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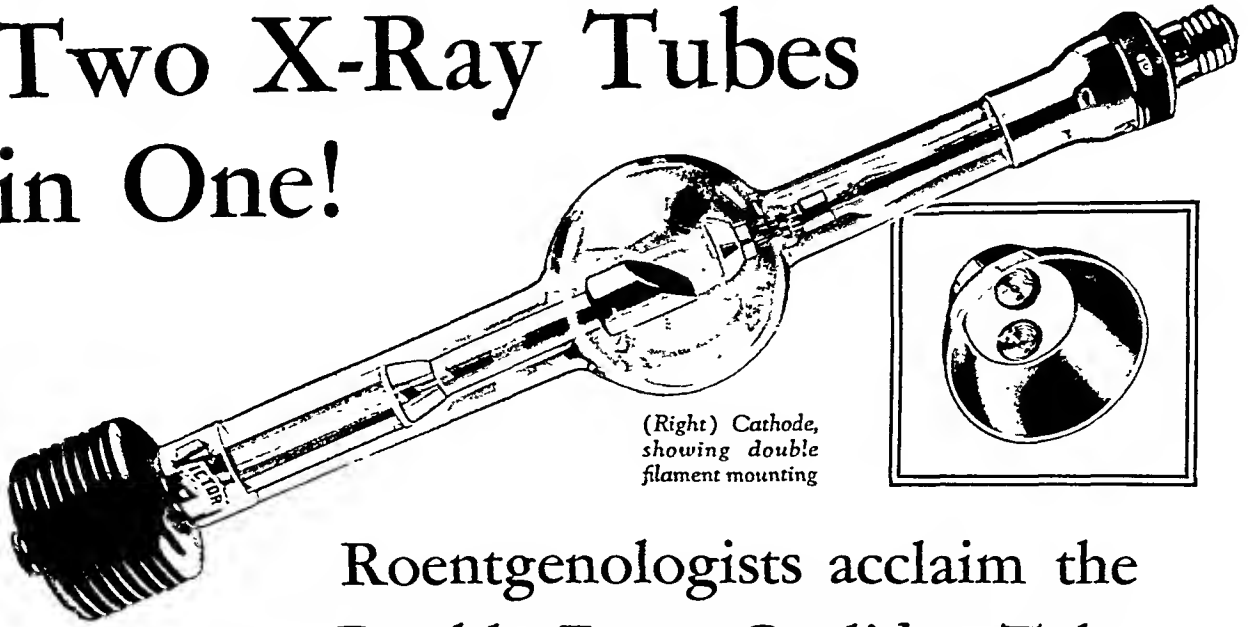
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# RADIOLOGY

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No. 5

## ENDOTHELIAL MYELOMA OR EWING'S SARCOMA<sup>1</sup>

By WILLIAM B. COLEY, M.D., NEW YORK

I HAVE chosen for the subject of my remarks Endothelioma. This group of tumors, while representing a smaller number of cases than the osteogenic group, deserves and is receiving special interest, chiefly because the majority of recoveries in bone sarcoma have fallen within it. While Howard and Crile<sup>2</sup> called our attention to a group of tumors which they classified as endothelioma, and reported four cases to which they added eighteen collected from the medical literature, their work, apparently, was soon forgotten. Ewing (1921-1922) was the first to point out that there is a group of tumors, originating chiefly in the shaft of the long bones, occurring mostly in children or young adults, and with very definite clinical, roentgenographic, and histologic characteristics which differ markedly from those found in osteogenic sarcoma and which entitle them to a separate classification. He further pointed out that these tumors, unlike the osteogenic sarcomas, are highly radiosensitive. The work of Ewing, therefore, had an important bearing on treatment, showing us in which cases we might safely subject the patient to conservative treatment, and in which (the osteogenic sarcomas), amputation should be performed immediately. Dr. Bradley L. Coley

and I have shown that these tumors are very sensitive to the toxins of erysipelas and *Bacillus prodigiosus*.

My first experience with endothelial myeloma dates back to my first case of bone sarcoma, treated in 1890; and as this case was the direct cause of my early and continued interest in bone sarcoma, I shall take the liberty of referring briefly to it here.

Case 1. The patient, a female, aged 18 years, had bruised her hand two months previously by catching it between the backs of two Pullman chairs. A few days later pain was felt in the third metacarpal bone, and a swelling developed shortly thereafter. The pain, which was very severe, was treated as rheumatism by several physicians. She was referred to me by Dr. W. G. Schauffler. I did not know just what the condition was, but I was sure that it was not rheumatism. On the belief that it was a tumor of some sort I performed an immediate biopsy. A tumor was found which had involved the middle portion of the metacarpal bone, was fusiform in shape, somewhat laminated in structure, and without definite new bone formation. On microscopic examination it was pronounced a small round-cell sarcoma. I asked Dr. William T. Bull to see the patient with me. An immediate amputation was advised, and on the following day I amputated at the middle

<sup>1</sup>Read in part in the Symposium on Bone Sarcoma, Baltimore, September 15, 1930, and in part before the Southern Surgical Association, December 15, 1930.

<sup>2</sup>Howard, William T., Jr., and Crile, George W.: *Ann. Surg.*, September, 1905, XLII, 358.

of the forearm. In four weeks she had metastases to both breasts, and in six weeks she died of generalization of the disease.

This was one of the most malignant cases of bone tumor in my entire experience, and was a typical example of so-called acute traumatic malignancy, developing almost immediately at the site of a definite bruise or local injury.

Case 2. Reviewing my earlier series, the next case that stands out as a definite example of endothelial myeloma is one that was admitted to my service at the Memorial Hospital in February, 1902. The patient, a male, aged 19, had a tumor of very rapid development, involving two-thirds of the shaft of the femur. I advised a hip-joint amputation, but this was refused. I performed a biopsy, and the tumor was pronounced by Dr. B. H. Buxton, pathologist of the New York Cancer Hospital (now the Memorial Hospital), and Dr. E. K. Dunham, Professor of Pathology of the Bellevue Hospital Medical School, a small round-cell sarcoma. The tumor showed little or no new bone production. We had just installed our first X-ray machine at the Memorial Hospital, and I thought it would be well worth trying it out in this case. To my surprise, immediate and rapid improvement in the condition was noticed. The tumor decreased rapidly in size. Unfortunately, in about five months, a large metastatic tumor, the size of one's hand, developed in the left pectoral region. This also was treated by radiation, under which it showed marked regression. When it had shrunk to about one-half of its original size, I removed it surgically. A few weeks later the patient developed a large tumor, about the size of a child's head, in the ilium. This tumor was not treated by radiation but by Coley's toxins only. Within six weeks it had become soft and fluctuating. I made an incision, inserted a large tube, and drained out nearly a pint of broken-down tumor material. The tumor entirely disappeared by



Fig 1 Endothelial myeloma of femur. Clinical and X-ray diagnosis confirmed by biopsy. Note the definitely laminated structure of the tumor. Patient recovered under toxins (Coley's) alone, limb saved. Patient was still well, twelve years later.



Fig. 2. Case 3. Typical case of endothelial myeloma of femur; laminated structure. Early symptom, pain above knee. Treated for five months for rheumatism and neuritis before a roentgenographic or even a clinical examination of the femur was made. The tumor practically disappeared under toxins and radium. One year later metastasis developed in the thoracic wall, the disease became generalized, and the patient died in a short while.

sloughing and absorption, the patient regained his usual health, and remained well for ten years, when he developed an entirely different malignant tumor at the site of an old X-ray burn on the thigh, which had followed over-radiation in 1902. This tumor developed very rapidly, became foul and fungating, and I did an amputation, more as a palliative measure than anything else. Pulmonary metastases developed and the patient died a few months later. The tumor of the amputated thigh and femur showed three different histologic types: (1) large round-cell sarcoma; (2) carcinoma of the soft parts, and (3) typical epithelioma with pearls (found in the medullary cavity of the



Fig. 3. Case 5 Endothelioma of femur, illustrating the difficulties in diagnoses. At the time this film was made a clinical diagnosis of chronic osteomyelitis was made and confirmed by an extensive exploratory operation and microscopic examination of tissue removed

femur). No type simulated that of the original tumors. The diagnosis was confirmed by Dr. James Ewing, Dr. W. W. Welch, and Dr. W. C. Clark.

This case is of special interest inasmuch as it is, I believe, the first endothelial myeloma that was treated by primary radiation during the operable stage. It showed not only the clinical and histologic characteristics of Ewing's sarcoma, but it proved to be highly radiosensitive, and still more susceptible to the toxins. It is one of the cases on record of the disappearance of highly malignant bone sarcoma, with extensive metastases, under any method of treatment, the patient remaining well years.

While I wish to devote more





Fig 4 Same case as shown in Figure 3. This film was made three months later, when, after further clinical and roentgenographic examination and a review of the microscopic sections, a diagnosis of endothelioma was made.

to a review of the treatment of endothelial myeloma and of the results obtained, I must refer briefly to the diagnosis, inasmuch as the method of treatment can be determined only after a correct diagnosis has been made. There is no type of bone sarcoma beset with greater difficulties in the diagnosis than the endothelial myeloma.

The most important points in the diagnosis are:

- (1) *The locality of the tumor*—usually the shaft of a long bone
- (2) *History of antecedent local trauma*—in about 50 per cent
- (3) *Rapid development*
- (4) *Early pain*. This is present in the great majority of cases, worse at night, in-



Fig 5 Another film of Case 5, made shortly before death.

creasing in severity, and not always referable to the site of the tumor but to a region some considerable distance distally from the tumor.

(5) *Age of patient*—usually childhood or youth; rarely after the age of thirty years.

(6) *Consistence of tumor*—softer than the osteogenic sarcoma.

(7) *Involvement of a considerable portion of the shaft of the bone*—rarely including the epiphysis

(8) *Metastases to neighboring glands or other bones*—often in comparatively early stages of the disease.

(9) *Local heat and not infrequently a moderate general temperature*—in rare cases this may rise to from 103 to 104 degrees.

(10) *Pathologic fracture in later stages of the disease.*

Referring to the age of onset, as mentioned above (see No. 5), the following tabulation is of interest:

| Age                      | Cases |
|--------------------------|-------|
| Under 5 years.....       | 8     |
| From 5 to 10 years.....  | 17    |
| From 10 to 15 years..... | 6     |
| From 15 to 20 years..... | 17    |
| From 20 to 25 years..... | 10    |
| From 25 to 30 years..... | 6     |
| From 30 to 35 years..... | 7     |
| From 35 to 40 years..... | 4     |
| From 40 to 45 years..... | 4     |
| From 45 to 50 years..... | 2     |
| From 50 to 55 years..... | 4     |
| From 55 to 60 years..... | 2     |
| From 60 to 65 years..... | 0     |
| From 65 to 70 years..... | 3     |

In this group, 11 per cent were under five years of age, 27 per cent were under ten years, 53 per cent were under twenty years, and 9 or 10 per cent were over fifty years of age.

Most of the mistakes in diagnosis can be traced to failure to obtain a careful clinical history or, what is even more important, a careful physical examination. In a few cases, failure may be attributed to lack of roentgenographic examination: the latter is of great diagnostic value. The characteristic appearance presented by the roentgenogram is that of a destructive process of the shaft of the bone involving all the layers, resulting in a general widening or thickening of the shaft, with little or no new bone formation. The bone often has a moth-eaten appearance.

To illustrate some of the difficulties associated with an early diagnosis, I would cite the following two cases.

Case 3. H. P., a male, aged 18 years, in the early part of 1928 noticed a dull, aching



Fig. 6. Case 5, showing metastases to the skull and jaw.

pain in the region of the left knee, which was more severe at night. A diagnosis of rheumatism was made and the condition was treated as such. No improvement being noticed, the patient, three or four weeks later, consulted a prominent orthopedic surgeon, who made a diagnosis of neuritis. The pain continued and became more severe in spite of treatment, and in the latter part of September, 1928, the patient was brought to the Hospital for Ruptured and Crippled, where a diagnosis of toxic pain in the knee was made, and the patient was advised to have his teeth and tonsils examined. Two weeks later, in Hartford, a roentgenogram was taken for the first time. This disclosed a very extensive sarcoma of the middle and



Fig. 7. Case 6. Endothelioma of femur, the roentgenographic and clinical picture of which closely resembled that of osteomyelitis. Macroscopic and microscopic diagnosis of osteomyelitis was made on biopsy. Instead, it proved to be a highly malignant endothelial myeloma. Amputation was followed by toxins; general metastasis; death one year after amputation.

upper third of the left femur, undoubtedly of the endothelioma type.

The patient was referred to me on October 20, 1928. He was admitted to the Hospital for Ruptured and Crippled, and physical examination at this time showed slight atrophy of the left thigh on inspection—no visible tumor. On palpation, an enlargement, firm in consistence, could easily be made out in the middle and upper portions of the left femur. The patient had lost about twelve pounds in weight. He was started on treatment with the mixed toxins in conjunction with radiation. On October 25 and 26, he had X-ray treatments, and



Fig. 8. Same case as shown in Figure 7, this film having been made just prior to amputation.

from November 1 to December 2 he received a total of 46,000 mc.-hrs. of radium. By December 8, 1928, he had regained his lost weight, and examination showed marked diminution in the size of the tumor. He returned home, where the toxins were continued two or three times a week. About three months later he developed severe pain in the cervical region and back. A few weeks later, definite tumors could be made out by roentgen-ray examination and palpation. In spite of further treatments with toxins and radiation he died on June 28, 1929, with metastases to the skull, neck, spine, and lungs.

In this case, I believe that, had a roentgenogram been made in the early stages of the disease and the diagnosis established

four or five months earlier, the result might have been different.

A second case illustrating the difficulties in diagnosis follows.

Case 4. W. C., a male, aged 14 years, was well until the beginning of 1928, when he sprained his right ankle. No ill results followed until the latter part of July, when, while camping, he was bitten by a mosquito on the same ankle. Pain and swelling were noticed on the following day. He was admitted to the Hospital for Ruptured and Crippled on August 9, 1928. Physical examination at this time showed the patient to be in fair condition, walking with crutches. The lower portion of the right tibia was moderately enlarged, thickened, and somewhat tender. There was no fluctuation, but some increased local heat.

Roentgenographic examination showed a low-grade osteomyelitis of the lower end of the tibia above the epiphyseal line. The treatment given was incision and drainage of the right tibia.

Three weeks later the plaster cast was removed. There was considerable bleeding and oozing, and the wound was redressed. The patient was readmitted to the Hospital for Ruptured and Crippled on September 11, 1928, and was given a transfusion of 500 c.c. of blood. Roentgen-ray examination on September 14, 1928, showed no evidence of increased bone involvement. Three days later, on dressing the wound, it was found to be covered with a grayish exudate, flecked with what appeared to be a blood clot, strongly suggestive of malignancy. The clot was cleaned out, whereupon severe hemorrhage followed which had to be controlled with a tourniquet. The removed tissue was sent to the laboratory for microscopic examination, being pronounced endothelial myeloma.

I first saw the patient on September 22, 1928, and after making a thorough physical and roentgenographic examination, as well

as reviewing the microscopic sections, I advised an immediate amputation, to be followed by toxin and radium treatment. The patient's father, who was a physician, would not consent to the amputation. Another transfusion was given, and on September 28 the radium pack was applied. In addition, he was put upon the toxins of erysipelas and *Bacillus prodigiosus*.

Roentgen-ray examination on October 12, 1928, consisted of two views of the right leg, showing extensive destruction of the tibia from the lower epiphyseal line upward for about three inches, with some irregular bone production and a large partially calcified mass in the soft tissues, especially on the posterior aspect. There was periosteal elevation at the upper limit of destruction, with what seemed to be a slight periosteal elevation of the fibula at the same level. The area of bone destruction appeared too sharply localized in proportion to the amount of destruction to suggest an infection; a malignant newgrowth seemed more probable. A film of the chest, made with a portable machine, showed no shadows suggesting metastases or other abnormalities. A Dakin tube was inserted in the soft tissue mass. Two weeks later the patient developed metastasis in the upper jaw; he went down-hill rapidly, and died within a few weeks.

In this case, valuable time was lost by the fact that the first specimen removed at biopsy failed to reach the pathological laboratory. After two or three weeks' persistent hemorrhage and a fungating wound, the presence of malignancy was suspected, and another specimen showed the condition to be, microscopically, an endothelial myeloma. By this time the patient had lost so much blood that his hemoglobin was down to about 50, and he was running a temperature of from 103 to 104 degrees.

This case is an example of the most malignant type of endothelial myeloma. The

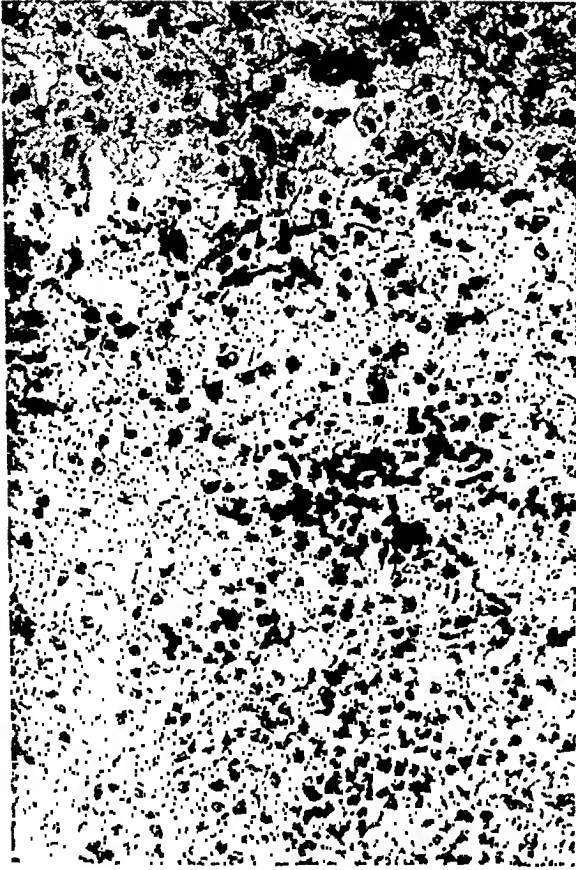


Fig. 9. Photomicrograph of tissue of Case 6.

whole course of the disease," from the time the tumor was first noticed until the patient died, was scarcely more than four months.

#### OSTEOMYELITIS

We find the greatest difficulty in making a differential diagnosis between endothelial myeloma and osteomyelitis. In certain cases it is impossible to make a positive diagnosis, even with all the aids at our command, including a biopsy and microscopic examination by experienced pathologists. Fortunately these cases are very rare; in the great majority we are able to make a diagnosis by carefully observing the following important points of difference.

First, we must distinguish the endothelial myeloma from a benign tumor. This is easily done if we remember that a benign bone tumor is more sharply localized; is

limited usually to a single portion of a bone (either the periosteum, the cortex, or the medulla, but seldom involving all these); is of long duration; is almost always painless; never involves the soft tissues in its vicinity; never metastasizes to glands or viscera; may be bone-forming (as an osteoma or a chondroma) or may be bone-destroying (as a benign cyst or a benign giant-cell tumor).

If we include the benign giant-cell tumor, or giant-cell sarcoma as classed by some, we may find great expansion of bone, with extensive bone destruction, the cortical layer finally becoming so thin that it gives the so-called "egg-shell crackling" feeling on pressure; or it may be completely destroyed and the tumor surrounded by soft parts. Unlike the osteogenic sarcoma, it never causes a true infiltration of soft tissues. If the benign tumor is in the shaft of a long bone, it never produces the periosteal stripping so commonly seen in osteogenic sarcoma. On account of the slow growth, it may need no treatment or no surgical removal unless it interferes with the function of the limb.

Malignant giant-cell tumor is dealt with elsewhere.

In cases in which it is impossible to distinguish between endothelial myeloma and osteomyelitis, it is well to treat the condition as one of endothelial myeloma and await the subsequent clinical progress to solve the problem of final diagnosis.

Case 5. *Sarcoma of the femur, endothelioma type.* The original diagnosis of osteomyelitis was based upon clinical, roentgenologic, macroscopic, and microscopic evidence.—The patient, P. T., a male, aged 14 years, was admitted to the Hospital for Ruptured and Crippled, service of Dr. Royal Whitman, on December 7, 1922, with the following history: Three months previously the patient began to limp and complained of pain in the region of the left hip. He became very restless at night; lost ten pounds in weight. There was no fever. Physical

examination at the time of his admission to the hospital showed the left leg to be held flexed at an angle of 160 degrees—it could be abducted at 15 degrees, and very slightly rotated outward. Flexion and extension were almost entirely restricted; internal and external rotation were somewhat restricted, and there was very marked tenderness to pressure over the great trochanter. A roentgen-ray examination was made at this time, and the report was as follows: "There is a general periosteal thickening of the upper extremity of the femur which apparently extends to a point four inches below the trochanter minor, involving the periosteum and extending up to the neck, but apparently not involving the neck of bone. The interior of shaft shows changes indicative of disease."

A Wassermann test was made and proved negative.

On December 11, 1922, the patient was operated upon by Dr. Whitman. A long incision was made down over the trochanter, through the muscles to the bone. Periosteal tissue and pus were at once encountered. The tissues were separated from the bone, and the external layer of the cortex was removed for a distance of about three inches. But one-third of the bone seemed to be involved, and nothing was found in the interior—the bone became solid. According to Dr. Whitman, the condition was evidently a periostitis and not an osteomyelitis except as a secondary condition. He stated that the tissues through which he cut were more or less laminated, simulating the different layers of an onion.

Pathological report by Dr. F. M. Jeffries was: "Extensive and intensive acute osteitis; etiology does not appear."

The wound was kept open and dressed with Dakin's solution and the patient was discharged on January 11, 1923. On February 7, 1923, he returned to the Hospital for Ruptured and Crippled for examination.



Fig. 10 Case 8. Endothelioma of clavicle in a child of 11 years, which developed rapidly immediately after a fall. Excision of the clavicle was followed by toxins and radiation. Rapid recurrence, not controlled by further treatment. Death occurred nine months from date of injury.

During the intervening month, a very great change had taken place in the thigh; it had increased in circumference to twenty-four inches. The veins were markedly dilated and distended. The swelling was firm in consistence, but not of bony hardness. Several of the inguinal glands were enlarged. At this time the clinical evidence of a rapidly growing inoperable sarcoma was beyond question. The patient was referred to me for treatment and was transferred to my service at the Memorial Hospital. Roentgen-ray examination at this time (February, 1923) showed that a very great change had taken place since the last examination was made. There was now a good deal of destruction of bone, without much new bone formation. Clinical and roentgenologic diagnosis was that of sar-



Fig. 11. Specimen removed, Case 8.

coma of the endothelioma type. The original microscopic sections were examined by Dr. Ewing, who pronounced them a sarcoma of the endothelioma type.

During his stay at the Memorial Hospital, the patient received treatment with the radium pack (50,000 mc.-hrs.), which was applied at a distance of ten centimeters over three different areas of the femur within a period of four days, and, in addition, he received systemic injections of the mixed toxins of erysipelas and *Bacillus prodigiosus*. During the following three weeks the tumor decreased very markedly in size, the circumference of the femur at the end of this time being fourteen inches. Roentgen-ray examination also showed marked changes to have taken place. The patient's general health improved. However, in April, 1923, he showed evidence of metastases in the

skull, jaw, and other regions of the body, and, in spite of further treatment, he died in June, 1923.

Case 6. *Endothelial myeloma of femur*.—The patient, A. M., a male, aged 30 years, was admitted to the New York Broad Street Hospital in August, 1924, where a clinical and roentgenologic diagnosis of osteomyelitis was made. An exploratory operation was performed, and the diagnosis confirmed by microscopic examination.

On January 23, 1925, he was admitted to the orthopedic division of the Hospital for Ruptured and Crippled. An exploratory operation was performed, and a microscopic diagnosis of chronic osteitis with no evidence of neoplasm made.

The patient had had little pain and no rise of temperature, but on April 18, 1925, he returned to the hospital complaining of pain. Upon examination, there was revealed a fluctuating swelling beneath the old incision. A third exploration was performed, which was followed by considerable hemorrhage. The pain seemed somewhat less severe.

On June 20, 1925, the patient was readmitted, complaining of intense pain. There was marked swelling about the incision, semifluctuant but not tender. There was a hard gland in the inguinal region measuring about three-fourths by one-half inch. His general appearance was cachectic. Roentgen-ray examination three weeks later showed that proliferative bony changes had taken place. There was also a very definite lifting and proliferation of the periosteum, particularly from the portion of the femur below the site of the disease.

I first saw the patient in consultation on July 17, and made a diagnosis of sarcoma. I urged an immediate amputation, but to this the patient would not consent. An exploratory operation was performed by Dr. Bradley L. Coley on July 21, and the specimen was submitted to Dr. Ewing, who reported

it to be a malignant tumor of the bone marrow, probably an endothelial myeloma. A pathologic fracture occurred later. In view of the large size and the rapid growth of the tumor, an immediate amputation was again urged, and was performed by Dr. Bradley L. Coley on July 31. Prophylactic toxin treatment was given for a considerable period. The patient remained in excellent health for over a year and regained over fifty pounds of lost weight. He was readmitted to the Memorial Hospital on January 1, 1928, at which time roentgen-ray examination showed a group of metastases in each lung. He was then given intravenous injections of toxins and a cycle of roentgen therapy. The disease reached a stage where the patient refused all further treatment, and its steady progress caused death in August, 1928.

Case 7. *Osteogenic sarcoma of the femur closely simulating osteomyelitis*.—I. L., a male, aged 20 years, in March, 1921, caught his left leg in the door of a subway train, and his thigh was severely squeezed. Nothing unusual was noticed until three days later, when he felt severe pain in the injured thigh just below the great trochanter. This was intermittent at first, keeping him in bed for a few days at a time, but later the attacks became more frequent. A swelling was noticed, which gradually increased in size. The patient was admitted to the Jewish Hospital of Brooklyn on July 25, 1923, where an operation (osteotomy and curetting of bone) was performed on August 7, 1923. A microscopic examination was made, and the report was as follows: "Specimen consists of degenerated soft tissue in which there are embedded small pieces of sclerotic bone tissue. *Microscopic diagnosis*: osteomyelitis of left femur." A section of this specimen was examined by Dr. F. M. Jeffries, whose diagnosis was that of productive osteitis. Dr. Ewing, who also examined a section, concurred in the diag-

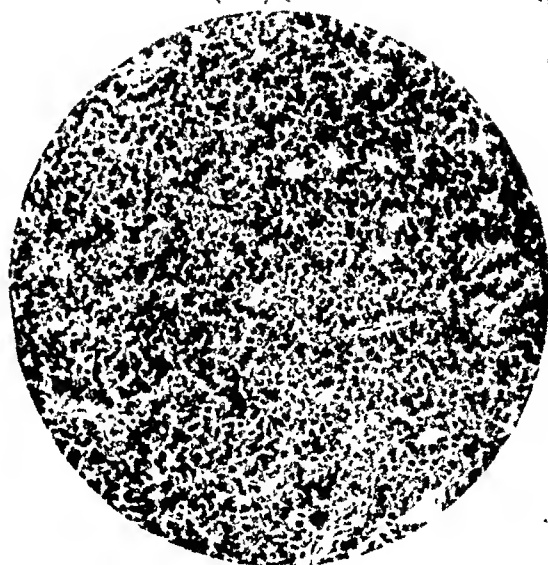


Fig. 12. Photomicrograph of tissue removed from Case 8.

nosis and said that one edge of the specimen showed a slight suspicion of possible neoplasm, but not enough upon which to make a diagnosis. Roentgen-ray examination made in 1923 showed nothing at all suggestive of sarcoma. There was a marked thickening of the femur, with sclerosing of the bone, typical of a chronic sclerosing osteitis. Physiotherapy treatment was begun in the latter part of 1924.

On March 13, 1925, the patient was admitted to the Hospital for Ruptured and Crippled. A roentgenogram taken at this time showed that certain changes had occurred since the last film was made: the bone was larger and thicker than it was at that time; the density seemed not quite so marked; instead of the periosteal line of the bone being intact, there were a few erosions in one area—a few indentations in the normal outline; apparently there was a small amount of new bone production beyond this normal line. The film, however, did not permit one to make a diagnosis of sarcoma, although it was more suggestive of sarcoma than the earlier ones. A few months later, no improvement in the condition having





Fig 13. Case 9, patient of Dr. S. L. Christian and Dr. L. A. Palmer. Tumor of tibia, of bone marrow origin, classified as endothelial myeloma or multiple myeloma. Amputation in September, 1925, was followed by extensive generalization of the disease to the bones and soft parts, and loss of weight (December, 1925). Under toxins alone, the patient made a complete recovery, and was in excellent condition in March, 1931, five years after treatment was begun.

been noted, the patient was admitted to Dr. Royal Whitman's service (Hospital for Ruptured and Crippled) and I was asked to see him. The clinical appearance of the tumor, as well as the roentgen-ray evidence, in my opinion, was strongly suggestive of a neoplasm rather than an osteomyelitis. An exploratory operation was per-

formed by Dr. Whitman on March 16, 1925, revealing soft, vascular tumor tissue which had broken through the muscle. This was examined microscopically by Dr. Jeffries, and pronounced a mixed-cell sarcoma. Dr. Ewing also examined a section, and he reported as follows: "Osteogenic sarcoma, polygonal cell, malignant." Amputation was advised and refused.

The toxin treatment was begun on April 1, 1925, and continued in gradually increasing doses for two months. At the end of six weeks' treatment, the circumference of the thigh had diminished two inches, and the patient's general condition had shown marked improvement. Low voltage roentgen-ray treatment was begun at the Memorial Hospital by Dr. Ralph E. Herendeen. From May 7, 1925, until November 13, 1925, the patient received seven exposures of sixty minutes each.

The patient remained well for about one year and then began to have vague pains in different parts of the body, especially in the affected femur. Roentgen-ray examination was negative. Later on, however, he developed evidence of metastases in the lungs, retroperitoneal glands, and various other parts of the body. In spite of further treatment (toxins and radiation), the condition gradually grew worse and he died a few months later.

#### OSTEOGENIC SARCOMA

The next step—and a very important one—in diagnosis is to differentiate the endothelial myeloma from the osteogenic sarcoma. This must be done at a comparatively early stage of the disease if we are going to give the patient that very fair chance of saving his life. Here, fortunately, it is possible to make a correct differential diagnosis in most cases by paying due heed to the following clinical and roentgenologic features.

Osteogenic sarcoma usually occurs at a slightly older age than does endothelioma. It has almost the same history of antecedent local trauma, *i.e.*, about 50 per cent, and pain is also the first symptom. As in endothelial myeloma, the pain may be a referred one, not occurring at the site of the tumor. This has led to many errors in diagnosis, the surgeon confining his examination to the locality of the pain and not examining or taking roentgenograms of the bone or bones higher up (see Case 3).

Unlike endothelial myeloma, osteogenic sarcoma usually begins at the extremity of a long bone, in the diaphysis, and seldom involves the epiphysis until the later stages of the disease have been reached. While it apparently begins in the periosteum or subperiosteum in the vast majority of cases, giving rise to the older classification of periosteal sarcoma which was adopted in all countries until recent years, it usually involves the central portion of the bone simultaneously or very quickly, without, however, destroying the layer of the cortex. The shape of the tumor is more or less characteristic. It is apt to be pear-shaped, the larger part corresponding to the end of the long bone and tapering off towards the middle of the shaft. There is often an elevation or a lifting of the periosteum along the shaft at the line of the advancing tumor. This is quite characteristic of osteogenic sarcoma.

The tumor itself is fairly smooth on palpation. Its consistency may give important information: it is not so hard as the chondroma or osteoma, nor so soft as the endothelial myeloma that has destroyed the cortex of the bone. There is a certain amount of resilience on palpation. The consistency may vary with the type of osteogenic sarcoma, being harder in the chondrosarcoma or the sclerosing ossifying sarcoma than in the more cellular types.

The rapidity of growth which enables one

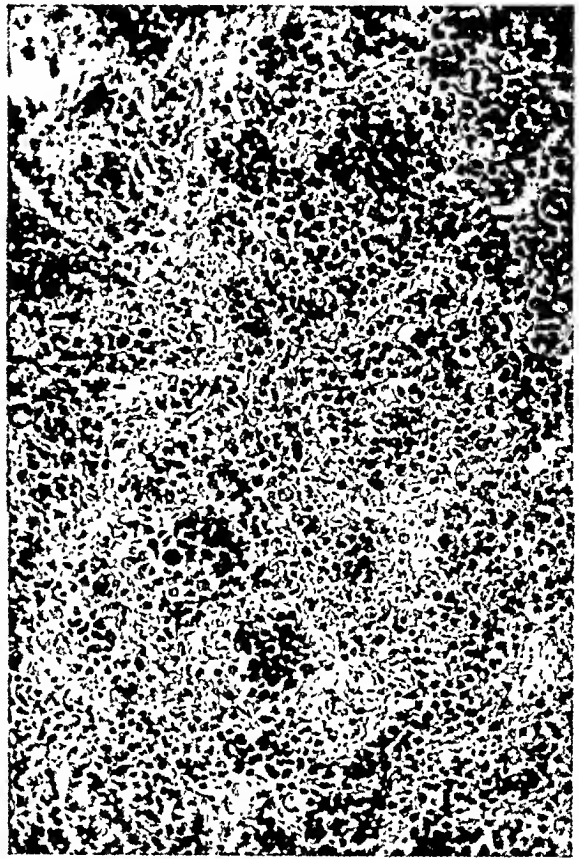


Fig. 14. Photomicrograph of tissue, Case 9.

to differentiate an osteogenic sarcoma from a benign tumor is of little help in distinguishing the former from an endothelial myeloma. While most writers have stated that osteogenic sarcoma is more rapid in growth than endothelial myeloma, and more quickly fatal, I hold a different opinion. These writers have based their statistics upon the duration of life in the 54 cases of the Bone Sarcoma Registry reported by Connor, without referring to the very natural explanation that increased duration of life in the cases that lived beyond one or two years was, in practically every instance, due to treatment with radiation or toxins. If we confine our examination to the older cases of sarcoma of the shaft of the bone, generally classed as round-cell sarcoma (prior to Ewing's publication of 1921), we find that this group was the most malignant of all types of malignant bone tumor.



Fig 15 Case 10. Spiral fracture of the shaft of the humerus (May, 1923), showing no evidence of a pathologic condition at the time of injury

That we have found the means to control this type of tumor (endothelioma) by a selected method of treatment, in a larger proportion of cases than it has been found possible to do in osteogenic sarcoma is most fortunate; but it should not let us fall into the error of regarding the endothelial group as a more benign form of bone sarcoma. I have seen an osteogenic sarcoma of the femur, in a boy aged 11, cause death in four months from the date of the trauma (kick) which was the apparent causative factor in the development of the tumor; and I have seen an endothelial myeloma of the humerus, in a boy aged 5, cause death in four months, in spite of heavy treatment. Obviously, the duration of the tumor gives us little information in differentiating the endothelial myeloma from the osteogenic sarcoma.

Case 8. *Endothelial myeloma of clavicle.*—A. P., a female, aged 11 years; family history negative. In the middle of February, 1924, the patient fell, striking on her left shoulder. A swelling appeared promptly which increased rapidly in size, until, two weeks later, when, having attained huge proportions, it remained stationary for a week. There was no pain and only slight limitation of motion.

The patient was referred to me on May 7, 1924, and was admitted to the Memorial Hospital. Physical examination at this time showed, at the top of the left shoulder, a globular swelling about three inches in diameter—or about the size of a small orange—markedly protuberant, and, apparently, originating in the outer half of the clavicle. The tumor was smooth in outline, soft, semi-fluctuating in consistence at the upper portion but firmer at the base. The skin was dark, almost purplish in color, over the upper portion, and stretched thin by the rapid growth of the tumor. The veins were dilated.

*X-ray report*, May 12, 1924: Stereoscopic plates of the chest revealed the presence of a destructive process involving the outer third of the left clavicle. The process extended in the medullary cavity into the middle third of the shaft of the clavicle; it was irregular in character and not limited or encapsulated. Very little bone production was seen; considerable of the cortex in the superior surface had been destroyed. The outline of a soft-part tumor above was noted. There was no evidence of metastasis to the lungs.

I excised the clavicle on May 14, 1924.

*Pathological report* (Dr. Ewing), May 14, 1924: The tumor involved 6 cm. of the clavicle, and 4 cm. of the shaft was largely destroyed by tumor tissue which had invaded the marrow cavity and dissolved most of the bony tissue. The tumor formed a globular mass 5 cm. high. It was well

circumscribed and pushed the skin before it. The tumor tissue was very soft—in places diffuent, elsewhere soft and opaque. Grossly it was a medullary and subperiosteal osteogenic sarcoma.

The tumor was composed of a very rich growth of small rounded or polyhedral cells, consisting almost wholly of hyperchromatic nuclei. They grew diffusely, or were arranged about small blood vessels, or inclosed spaces in which there was blood or other fluid. There was no bone production anywhere, and no osteoid tissue. There was no stroma between the cells. The appearance was that of a very anaplastic tumor. It seemed to fall in the group of endothelial myeloma.

Immediately after the operation, bare tubes of radium (8 millicuries) were buried in the wound. There was some sloughing at this point. Two weeks later the toxin treatment was begun and kept up until August, 1924, after the patient had returned home. Early in August a local recurrence took place. A massive dose of radium was applied. In spite of this and continued toxins, the disease progressed steadily and caused death on November 28, 1924, nine months after the injury.

#### THE ROENTGENOGRAM

The roentgenogram is often of the greatest help, and, in many cases, it, in conjunction with the clinical history and physical signs, enables one to distinguish both the endothelial myeloma and the osteogenic type of sarcoma.

If we are dealing with an endothelioma, the roentgenogram will show a tumor of the mid-shaft, osteolytic in type, whose destructive process has involved all the layers of bone. The tumor replacing the destroyed bone often presents a laminated structure, with little or no new bone formation. If, however, we are dealing with an

osteogenic sarcoma, the roentgenogram will usually show a tumor of the end of a long bone made up largely of new bone, or new bone and cartilage, superimposed upon the cortex, without expansion of the cortex, and infiltrating more or less the adjacent soft parts. The roentgenogram will commonly show an involvement of the medullary portion, but the actual involvement of the medulla is much greater than is apparent, as has been proved by subsequent amputation. The new bone is frequently arranged in spicules, at right-angles to the axis of the long bone. This does not occur in all cases, as one might be led to believe from most text-books, but in less than one-fourth of the cases, according to Kolodny's study of the Bone Sarcoma Registry cases. From my personal experience I should say that I have observed it in less than one-third of the cases. When it does occur it may be regarded as almost pathognomonic of osteogenic sarcoma, although in certain very rare cases of osteomyelitis this type of new bone formation has been found.

#### BIOPSY

In a number of cases, in order to make a positive diagnosis, a biopsy and microscopic examination will be necessary. While some writers, notably Ewing, are opposed to biopsy in endothelial myeloma, I believe it should always be performed in the small group in which one is otherwise unable to make a correct diagnosis. The importance of knowing the nature of the tumor before prescribing the type of treatment to be employed far outweighs the so-called disadvantages of a biopsy. My opinion is that these disadvantages are more theoretical than practical.

The biopsy should not be performed as a routine measure in all or in almost all bone tumors, but should be reserved for cases in which there is a reasonable doubt



Fig. 16. Same case as shown in Figure 15, this film having been made one year later, showing a very extensive endothelial myeloma of the humerus at the site of the fracture. The condition was inoperable at the time of the author's first observation. The case was treated with toxins for two and a half years in addition to two radium pack treatments. Good recovery was made, the patient being well six and a half years later, with a useful arm.

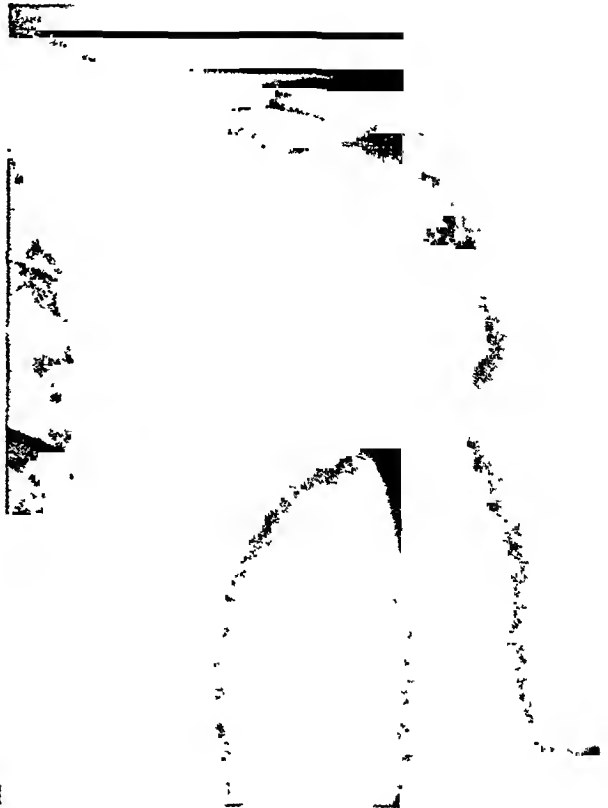


Fig. 17. Same case as shown in Figures 15 and 16, this film having been made fourteen months after treatment was begun. The fracture united without immobilization of any kind, the entire period of disability being three months.

after all the other aids to diagnosis have been employed. It should be performed only by the surgeon who is to have the subsequent care of the patient, and who is prepared to carry out the best method of treatment as determined by the biopsy; namely, if the biopsy shows the condition to be one of endothelial myeloma, then the patient should be given conservative treatment with Coley's toxins and radiation. This offers a fair hope of saving the limb as well as the life of the patient. Only after failure to control the disease by conservative treatment should amputation be performed.

On the other hand, if the biopsy reveals an osteogenic sarcoma, especially with considerable new bone formation, we know that

we are dealing with a tumor which is highly resistant to both toxins and radiation, and that there is almost no hope of saving the limb by conservative treatment. Furthermore, we know from long and larger experience that preliminary radiation in such cases does not improve the prognosis of the later amputation, which will almost certainly be necessary in a few months. For this reason we should be prepared to do an immediate amputation if the biopsy shows the tumor to be an osteogenic sarcoma. Dean Lewis advocates making the diagnosis from a frozen section at the time of biopsy, and, if the diagnosis is positive, to proceed at once with the amputation while the tourniquet is still on, thereby lessening the chances of metastases from tumor cells getting into the circulation at the time of the operation. While I have employed this method in a

few cases, I believe that there are not a few instances in which it is impossible to make a positive diagnosis from the frozen sections alone, and that one must wait for decalcification of the bone and for the paraffin sections. I think there is very little actual risk from this delay. In a number of cases, with a typical clinical history, the macroscopic appearance of the tumor, as disclosed at biopsy, has been so characteristic that I have been willing to amputate without waiting for sections.

During the last year we have used the aspiration method of diagnosis in a considerable number of bone tumors. While it has not proven of great value in the osteogenic type with much new bone formation, it has proved very useful in the endothelial myeloma type, making a biopsy unnecessary in a large proportion of cases.

#### TREATMENT

Having made a correct diagnosis, the important question arises: What method of treatment should be advised? Surgery alone has given very poor results: only one case in 22 reported by Howard and Crile was alive three years after amputation. I have never seen a case cured by amputation alone, but, then, I have not had a large experience with this method, having adopted prophylactic toxin treatment after amputation as a routine measure many years ago.

A review of the literature does not help us reach a definite decision. Connor's<sup>3</sup> series of 54 endotheliomas collected by the Bone Sarcoma Registry (up to 1926) shows only four patients alive and well five years after treatment. Various methods were employed. One myeloma of the os calcis was treated by amputation alone by Dr. J. E. Thompson, of Galveston, the patient remaining well for eight years. The other three five-year recoveries were

my own cases. All were treated with toxins plus surgery. One had amputation and prolonged post-operative toxin treatment. One with metastasis to the glands of the groin before amputation, had post-operative toxins for three months, and one application of the radium pack over the large tumor (size of a child's head) in the iliac fossa. This patient, furthermore, according to Dr. Herendeen's report, had pulmonary metastasis. He is now well, ten and one-half years later. The third case, an even more remarkable one, is a boy, aged 3½ years, upon whom Dr. Stuart McGuire, of Richmond, Va., had performed a hip joint amputation for a periosteal sarcoma of the femur one and one-half years before (in 1917). The original diagnosis was round-cell sarcoma; that of Dr. Ewing and the Bone Sarcoma Registry was endothelial myeloma. I first saw the boy in June, 1919, at which time he had a large tumor which involved nearly all of the right parietal bone, almost completely destroying the bone. There was marked exophthalmos of the right eye, and impaired vision. A similar area of bone destruction was found in the occipital region. Although the prognosis seemed absolutely hopeless I decided to try a combination of local radiation and systemic toxins (Coley's). A lead tray (2,000 millicurie-hours of radium) was applied at 3 cm. distance over the parietal bone, and a similar dose was applied to the top of the head, to the right of the median line. In addition, the patient was put upon systemic injections of the toxins at once. After three or four weeks, marked improvement was noticed. He returned home and the toxins were given there by his family physician. I saw him again six months later and found that the improvement had been continuous. A second dose of radium was given as before, and the toxins were resumed. When the patient returned to me again, at the end of another six months, examination showed that the

<sup>3</sup>Connor, Charles L.: Arch. Surg., April, 1926, XII, 789.

tumor had apparently entirely disappeared, the destroyed bone had been replaced by new bone, the exophthalmos had disappeared, and he had regained his normal health. He was given another radium treatment at this time, more as a precautionary measure, and the toxins were kept up in small doses, with occasional intervals of rest until he had received them over a period of four years. He has been in excellent health ever since, now over eleven years since the treatment was first begun.

These last two cases would seem to furnish convincing evidence of the value of the toxins in endothelial myeloma even if there were no other cases on record.

The following case of Christian and Palmer is undoubtedly the most remarkable one thus far reported.

Case 9. *Endothelial myeloma or multiple myeloma, primary in the tibia. Two months after amputation multiple tumors developed in the skull, clavicle, and femur; metastases to the groin and abdominal wall.*<sup>4</sup>

The patient, G. B., a male, aged 31 years, a master mariner, was admitted to the U. S. Marine Hospital, Stapleton, S. I., under the care of Dr. S. L. Christian and Dr. L. A. Palmer on June 30, 1925, with a history of having injured his left tibia in February,

<sup>4</sup>For full report, see Christian, S. L., and Palmer, L. A.: *Military Surgeon*, July, 1927, LXI, 42, and *Am. Jour. Surg.*, February, 1928, IV, 188.

#### DIFFERENTIAL DIAGNOSIS

| Symptoms                               | Endothelioma  | Osteogenic sarcoma   | Osteomyelitis  |
|--|---|--|--|
| 1. Age of patient                      | Children and young adults. Lesion usually single in early stage | Young adults and middle age. Lesion single                           | More common in youth. Lesion multiple or single          |
| 2. Antecedent local trauma             | In 50 per cent  | In 50 per cent   | In 33 per cent   |
| 3. Duration                            | Short   | Short  | Apt to be longest  |
| 4. Pain                                | Usually first symptom   | First symptom  | First symptom  |
| 5. Local swelling                      | Few weeks or months after pain                                  | Few weeks or months after pain                                       | More slowly developing                                   |
| 6. Local temperature                   | Rare in early stages, common in later                           | Few weeks or months after pain                                       | Rare in early stages, common in later                    |
| 7. General temperature                 | Infrequent; usually 99° to 102°, may reach 104°                 | Rare   | Rare or low-grade  |
| 8. Location of tumor. X-ray appearance | Shaft of bone, usually more than one-half                       | Either end of the diaphysis of long bone, usually less than one-half | Shaft of bone, but less than one-half and more localized |
| 9. Clinical character of tumor         | Bone destruction; laminated structure                           | Bone-forming; new bone spicules radiating at right-angles to shaft   | New bone, eburnation, sequestrum, and abscess            |
| 10. Multiple in bone                   | Usually   | Rarely   | Rarely   |
| 11. Metastases to glands               | Not infrequent  | Very rare  | None   |
| 12. Radium—effect                      | Radiosensitive  | Radioresistant   | No response to radiation                                 |
| 13. Toxins (Coley's)—effect            | Very sensitive to toxins  | Resistant in most cases; highly cellular types may be susceptible    | No response to toxins                                    |

1918. There had been recurrent attacks of pain, swelling, and tenderness in the same tibia for a number of years. The condition was regarded as osteomyelitis, and an operation had been performed on August 18, 1919. In April, 1925, a swelling was noticed a little higher up on the same tibia. A roentgenogram showed marked decalcification of the upper third of the left tibia, with only part of the skeleton of bone remaining, appearing like a bone dissolving under corrosive fluid, in the anterior upper third of the tibia. A film taken three months later showed further advance of the erosion, as well as a pathologic fracture at the junction of the upper and middle thirds of the tibia. A biopsy was performed on September 11, 1925, and the laboratory report was: "Myelosarcoma, very cellular, with slight fibrosarcomatous structure. The growth is composed of a mass of cells without regular arrangement. The cell units are small, polyhedral, with indistinct borders, often appearing as a syncytium. They are very uniform in size."

On September 21, 1925, an amputation at the middle third of the thigh was performed. The pain in the stump persisted, and two months later a nodule appeared beneath the skin just above the umbilicus. A specimen of this was examined by Dr. Ewing Taylor, who pronounced it a myelosarcoma, metastatic.

By January 5, 1928, a tumor the size of a man's fist had developed on the inner aspect of the stump, and another growth, about the size of a lemon, over the outer aspect. Also, there was a mass  $2 \times 1 \times 2$  inches in the left inguinal region, and one, three-quarters of an inch in diameter, in the supra-umbilical region, involving the skin. The stump measured 19 inches in circumference.

Injections of Coley's toxins were begun in the first week of January, 1926, severe reactions following. By January 22 the cir-

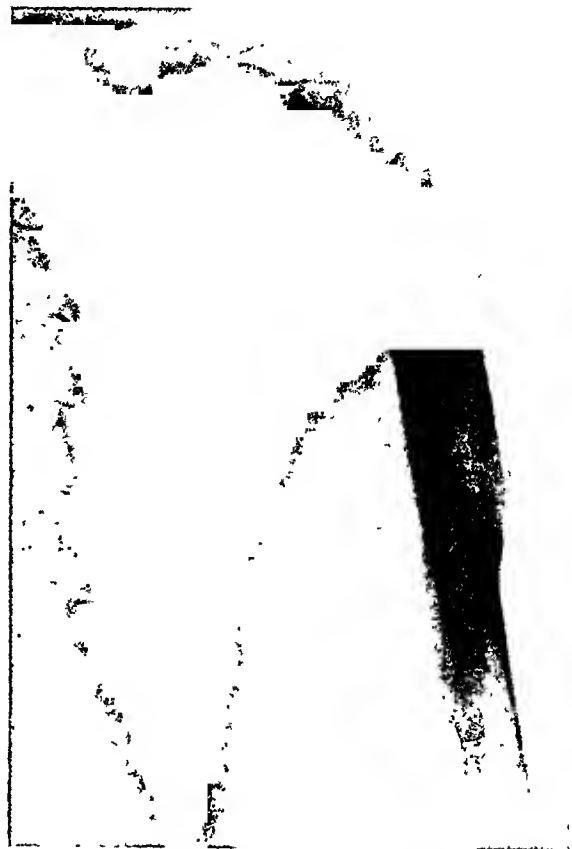


Fig. 18. Same case as shown in Figures 15-17, this film having been made five years after the original fracture.

cumference of the stump had diminished  $1\frac{7}{8}$  inches, the mass in the groin had disappeared, and the supra-umbilical mass was decidedly smaller and softer. The toxins were continued in doses as high as 18 minims daily. By February 20, they had to be discontinued owing to the extreme weakness of the patient. At this time the stump had taken on new growth, associated with considerable edema of both good leg and stump. On March 27, 2 minims of Coley's toxins were injected directly into the tumor mass on the stump. By April 7, the patient was receiving 5 minims into the tumor, which dose was followed by marked reaction. During May and June the patient grew steadily worse, with multiple metastases appearing in many parts of the body, including the right clavicle, scalp, cranial bones, and cervical vertebrae. The stump had reached



a circumference of 31 inches; the end of it had broken down over an area about five inches in diameter, from which there was a foul, profuse, ichorous discharge.

On August 5, 1926, Coley's toxins were resumed and by the end of a month the dose had reached 17 minims. By this time, marked improvement was noticed both in diminution in the size of the stump and disappearance of many of the metastatic nodules. By November 22, the general condition of the patient was excellent, his weight was 147 pounds (in the beginning of the same year it was 117 pounds), the stump-wound had healed, and the nodules in the abdomen, umbilical region, scalp, and skull had entirely disappeared. At the present time (January, 1931), five years since the treatment was begun, the patient is still in excellent health, with no evidence of a recurrence of the disease.

This case (No. 1143) has been classified by the Bone Sarcoma Registry as a Ewing's sarcoma.<sup>5</sup>

Case 10. *Endothelioma of upper two-thirds of shaft of humerus; pathologic fracture.* Treated with toxins and radium. Patient well six and one-half years since beginning of treatment. The patient, E. M., a male, aged 47 years, was referred to me by Dr. William C. Sheehan and Dr. John B. Deaver, of Philadelphia, in July, 1924, for a tumor that had started in a fracture of the left humerus—the upper third. One year later a tumor had developed at the site of the injury. On examining the patient I found his left shoulder to be markedly enlarged over the outer and anterior aspects, the swelling occupying the whole region of the deltoid and extending up to the tip of the clavicle. It was soft in consistence, semi-fluctuating, and extended out to the pectoral muscle. Motion at the shoulder was considerably limited. The skin was

normal in appearance and there were no dilated veins.

In this case the roentgenologic and clinical evidence was so clear that it was possible to make a definite diagnosis without a biopsy. In the opinion of most of the surgeons who had examined the patient, the condition was one that was beyond shoulder joint amputation. He was treated with toxins (erysipelas and *B. prodigiosus*) injected directly into the tumor, supplemented by radium pack treatments, 10,000 mc.-hrs. of radium being applied at 7 cm. distance over three different areas. Another radium pack treatment was given in December, 1924. In the first four weeks of treatment, the tumor diminished five inches in circumference, and the patient regained his lost weight. He proved highly susceptible to the toxins, a very small dose producing a temperature of 104.5°. The injections were continued until April, 1926. Prior to that, in February and March, 1925, the patient had resumed his arduous work as a landscape gardener. There was reunion of the pathologic fracture and complete restoration of function. He is still well at the present time (January, 1931), six and one-half years since the beginning of treatment.

In this case the diagnosis of the Bone Sarcoma Registry (see Case No. 596) was Ewing's tumor.

Case 11. *Endothelioma of the fibula, with extensive metastases to the femoral, inguinal, and iliac glands, and probably to the lungs.* Treated by amputation, toxins for three months, and one application of radium to the groin. Complete recovery; patient well eleven years later. The patient, H. S., a male, aged 8 years, was first seen by me in consultation with Dr. Royal Whitman, in May, 1920. Five months previously the patient had been struck on the outer side of the right leg, shortly after which pain and swelling had developed. An operation was performed by Dr. Whitman in March, 1920,

<sup>5</sup>This patient was presented at the New York Surgical Society meeting on March 25, 1931.

and a clinical and roentgenologic diagnosis of osteomyelitis had been made. Microscopic examination, however, showed the condition to be a periosteal sarcoma.

When I first saw the patient, the lower two-thirds of his fibula was occupied by a large tumor, apparently of periosteal origin, fungating in the central portion at the site of the recent curettage. The glands in the groin were enlarged—one was the size of an English walnut. I advised an immediate amputation, which was performed by Dr. Whitman. Both Dr. Jeffries, of the Hospital for Ruptured and Crippled, and Dr. Ewing, of the Memorial Hospital, regarded the tumor as an endothelioma.

The patient was immediately started on toxins, which were given at first daily, and then three times a week. The glands in the groin decreased somewhat in size but did not disappear. In July, a gland was removed for microscopic examination and pronounced a round-cell sarcoma (endothelioma). The toxins were continued until the middle of August, when the patient was permitted to go home on account of the excessive heat. Re-examination on October 23 showed the inguinal glands to have increased in size, and a hard mass the size of a child's head was discovered in the right iliac fossa, evidently involving the retroperitoneal glands. A roentgenogram of the chest was taken, which, Dr. Herendeen, roentgenologist of the Memorial Hospital, reported as showing unquestionable pulmonary metastases. The radium pack, consisting of 10,109 mc.-hrs. of radium, was applied at 7 cm. distance over the groin. As a hopeless prognosis had been made, no further treatment was employed.

The patient was next seen in September, 1921, when careful examination failed to reveal any evidence of a tumor in the abdomen or groin, and a roentgenogram of the chest showed no evidence of the metastases that had been present in the preceding



Fig. 19. Case 11. Sarcoma, endothelioma type, of the fibula, with extensive metastases to the inguinal and iliac glands. There was also evidence of pulmonary metastasis. Amputation was followed by toxins and one radium treatment over the iliac fossa. The patient recovered and was well in March, 1931, eleven years later.

October. The patient was in excellent health and had been attending school regularly. He is still well at the present time (January, 1931), eleven years later.

In this case the diagnosis of the Bone Sarcoma Registry (see Case No. 267) was Ewing's sarcoma.<sup>5</sup>

The following case is another example of an angio-endothelioma, with multiple metastases (pulmonary), which were held under control for more than five years by toxins and radiation.

Case 12. *Sarcoma, angio-endothelioma type, of tibia and fibula.* The patient, C. P., a male, aged 28 years, was admitted to the Memorial Hospital in August, 1924. One year previously he had complained of pain and swelling in the calf of the left leg. The condition was first regarded as myositis ossificans. In September, 1923, the tumor was removed and a diagnosis of alveolar



Fig 20 Same case as shown in Figure 19.

sarcoma was made. Intensive roentgen therapy was administered. In August, 1924, the patient complained of severe pain and weakness in the upper end of the fibula, and, at the same time, a swelling was noticed in the lower end of the tibia.

Roentgen-ray examination on his admission to the Memorial Hospital showed a central tumor of the tibia that had destroyed the bone for a distance of three or four inches. A film of the chest showed distinct evidence of pulmonary metastasis. Under continued roentgen therapy, the disease was kept under fair control until the Summer of 1925, when the tumor of the tibia and the metastatic tumor of the lung began to show evidence of increase in size. The patient was readmitted to the Memorial Hospital

and put upon toxins. By September 14, 1925, he had received 22 injections, in doses sufficient to produce a rise of temperature to 104 or 105 degrees, whereupon the injections were discontinued. Examination at this time showed decided improvement in the patient's condition—he had gained 18 pounds in weight, and there was evidence of some regression of the tumors of the tibia and lung.

A pathologic fracture had occurred which showed no tendency to unite, and, as the limb was entirely useless, it was thought advisable to amputate it. This was done by Dr. Bradley L. Coley on June 2, 1926. Dr. Ewing's diagnosis was angio-endothelioma, very bizarre structure.

Examination on November 23, 1926, showed the patient in very good general condition: he had gained 15 pounds in weight, and there was no evidence of any increase in the metastasis to the lung. Another course of toxin treatment was administered. He was still in good condition in November, 1929, at which time roentgen-ray examination showed no exacerbation of the disease in the lung; if anything, there was evidence of some diminution. A few days later he had an attack of coal-gas poisoning, followed by severe headaches. He went into a coma and died on January 1, 1930. No autopsy was performed, so that it is impossible to say whether death was due to the disease or to coal-gas poisoning.

In this case the diagnosis of the Bone Sarcoma Registry (see Case No. 574) was metastatic hypernephroma.

#### RADIATION

While it is perfectly legitimate to try conservative treatment in endothelioma of the long bones, I do not think we are any longer justified in trying to save the limb by either radiation or toxins in osteogenic sarcoma. Some fifteen years ago, when we had acquired our first large amount

of radium at the Memorial, and had installed high voltage X-ray machines, I believed we were justified, especially inasmuch as the Memorial Hospital was a research institute, in trying out these newer methods of treatment in the hope of improving the very bad prognosis which surgery alone offered in these cases. Primary radiation was employed as the method of choice in a very large number (121) of early operable cases of osteogenic sarcoma and endothelioma. We believe that a careful study of the end-results obtained in this series should furnish valuable data from which one may be able to formulate some general rules as regards future treatment.

Of the 121 cases of operable malignant tumor (osteogenic sarcoma and endothelioma, exclusive of giant-cell tumor) of the long bones treated by radiation as the primary method of choice, 62 became inoperable or developed metastases while undergoing treatment. Only one case recovered and remained well for five years. Unfortunately, in this case no microscopic examination was made. While the diagnosis made at the Hospital for Ruptured and Crippled, before the patient was transferred to the Memorial, was that of osteomyelitis, the Bone Sarcoma Registry has classified this as a case of endothelioma.

Of another group of 59 cases in which amputation had to be performed after failure to control the disease by radiation, six have remained well for a period of five years. So that, of a group of 121 cases treated primarily by radiation, we have seven (or 5.78 per cent) well for five years or more.

In spite of these exceedingly unfavorable results following primary radiation—which I am certain are not generally known to the profession—I believe that the majority of cases of osteogenic sarcoma of the long bones in the United States are being treated to-day by primary radiation as the method

of choice. During the last few weeks I have had under my care a man, aged 40 years, suffering from a periosteal osteogenic sarcoma of the middle third of the femur, which had been treated for eight months at one of the largest and best hospitals in New York with radiation, after the diagnosis of osteogenic sarcoma had been established by an early biopsy. This treatment was continued in spite of the fact that the tumor was steadily growing and was accompanied by increasingly severe pain. When the patient was admitted to the Hospital for Ruptured and Crippled the tumor had reached such a size that it was beyond hip joint amputation. The biopsy wound had become a large, fungating opening extending into the depths of the tumor, discharging seropurulent material. The condition was beyond hope of benefit from any form of treatment—the patient was simply made as comfortable as possible. Shortly after his admission he began to have slight hemorrhages from the fungating wound, which, becoming more and more frequent and profuse, could not be controlled, and two weeks ago he died. Fortunately we were able to perform an autopsy. This revealed one quart of blood in the large cavities of the tumor, but no metastases in the lungs or elsewhere, so that, had an early amputation been performed at the time the diagnosis was made, in all probability the life of the patient would have been saved.

The first large single series of endotheliomas to be published was that of Dr. Bloodgood's clinic at Johns Hopkins, reported by Geschickter and Copeland,<sup>6</sup> a paper which is one of the best and most noteworthy ones ever written on the subject. It is based upon a careful clinical, roentgenologic, and histologic study of 60 cases observed at the Johns Hopkins Hospital, and gives the end-results obtained by various

<sup>6</sup>Geschickter, Charles F., and Copeland, Murray M.: *Arch. Surg.*, February, 1930, XX, 246; March, 1930, XX, 421.



Fig. 21. Case 12. Angio-endothelioma of the tibia and fibula, with metastasis to the lungs (August, 1924). It was controlled temporarily by radiation. Toxin treatment was begun in August, 1925, followed by some improvement in condition and gain in weight. Because of non-union of the pathologic fracture and the useless condition of the limb, amputation was performed in June, 1926. Intravenous toxins were given, with occasional intervals of rest, for three years. Patient in good condition, and films of the chest made in November, 1929, failed to show any evidence of exacerbation of disease in the lungs. A few days after this examination the patient had an attack of coal-gas poisoning, followed by severe headaches. One month later he went into coma and died in a few hours. Since no autopsy was performed it is impossible to say whether death was due to disease or to coal-gas poisoning.

methods of treatment. The series is divided as follows:

*Group 1:* 13 cases treated by amputation or resection with irradiation; 3 well over five years.

*Group 2:* 24 cases treated by amputation or resection without irradiation; 4 well over six years.

*Group 3:* 8 cases treated by irradiation alone or with exploratory operation; none well over five years.

One case (humerus) in which Coley's toxins were used, died fourteen months

later. I regret to say that the authors, in both of their reports, state that "Coley's toxins have had no effect on the duration of life, either when given alone or combined with other forms of treatment." While they refer to three cases in which the toxins were used, their tables mention only one, and no details are given as to whether it was operable or inoperable. It would seem that this opinion on the value, or lack of value, of Coley's toxins was based upon much too meager personal experience to justify such a broad and unqualified verdict. Certainly even a limited review of the recent literature on bone tumors would have shown that the toxins had proven of great value, not only in my own hands but in those of other men. Without further argument, I am quite willing that my readers shall form their own opinions after reading the end-results obtained in a series of 86 cases personally observed at the Memorial Hospital and the Hospital for Ruptured and Crippled.

#### END-RESULTS IN 86 CASES OF ENDOTHELIOMA PERSONALLY OBSERVED

Thirty-four cases were *treated by radiation alone*. Only one case remained well for five years, and in this case, unfortunately, there was no microscopic confirmation of the diagnosis. It was pronounced an endothelial myeloma by the Bone Sarcoma Registry solely on the clinical and roentgenologic evidence.

Twenty cases were *treated with toxins alone or toxins and surgery*. Twelve have remained well for from five to twenty-two years. The diagnosis was confirmed by microscopic examination in all but one case; in this, there was a large, rapidly growing, inoperable tumor, involving the upper half of the femur, which had developed in a young boy shortly after an injury. The patient was emaciated and cachectic at the

time treatment was begun. He recovered under toxins alone and is well at present, ten years later. There can be no reasonable doubt of the diagnosis in this case. Of these 12 cases, four were inoperable at the time treatment was begun, and in three cases extensive metastases had already taken place. In four of the cases the limb was saved. Six were treated by toxins and amputation, and two by toxins and resection.

Thirty-two cases were *treated with toxins and radiation*. Nine have remained well for from five to thirteen years. The diagnosis was confirmed by microscopic examination in all but two cases. In one of these a diagnosis of endothelial myeloma was made by the Bone Sarcoma Registry from the clinical and roentgenologic evidence alone, which was quite characteristic. In the other, there was a huge, inoperable tumor involving the upper half of the femur. The condition was beyond hip joint amputation, and was regarded as hopeless by the members of the Memorial Hospital staff. There was a pathologic fracture and destruction of four inches of bone. Under eight months' toxin treatment and one application of the radium pack, the patient made a complete recovery and has remained well for thirteen years. In this case, the tumor had none of the characteristics of a giant-cell sarcoma. Its rapid development and prompt response to toxins and radium, in my opinion, makes the diagnosis of endothelioma reasonably positive. Of the nine recoveries in this last group, five were inoperable when treatment was begun, and in three cases metastases had already occurred.

#### BRIEF RÉSUMÉ OF INOPERABLE CASES SUCCESSFULLY TREATED

E. M. (Case 10), a male, aged 47 years. Endothelial myeloma of upper two-thirds of the shaft of the humerus following a recent fracture; inoperable; pathologic frac-

ture. Treated with toxins and radium. Fracture re-united and all evidence of disease disappeared. Patient well six and one-half years after the beginning of treatment. Bone Sarcoma Registry Case No. 596.

C. P. (Case 12), a male, aged 28 years. Angio-endothelioma involving the lower end of the tibia and the upper end of the fibula. Intensive roentgen therapy for one year. Developed pulmonary metastasis. Toxin treatment begun in July, 1925. A pathologic fracture had occurred, which failed to unite, and, the leg being useless, an amputation was performed in June, 1926. Intravenous injections of toxins given, with occasional intervals of rest, for a period of two years. Patient in good condition; metastasis held under complete control, as shown by roentgenogram in November, 1929. At that time he had a severe attack of coal-gas poisoning. One month later he went into a coma and died in twenty-four hours. No autopsy; cause of death unknown. Case No. 574 in Bone Sarcoma Registry.

W. L. B., a male, aged 6 years. Endothelial myeloma of femur following a trauma in 1916; amputation by Dr. Stuart McGuire in 1917. One year later extensive metastases developed in right parietal and occipital bones, with marked exophthalmos. Treated with toxins, and radium pack over the parietal bone only. In August and October, 1919, and March, 1920, patient received a radium lead-tray treatment over the right temporal and right parietal regions. In April, 1920, further metastasis developed in the occipital region; patient received two more treatments with radium lead-tray. Toxins kept up for a period of five years. Patient made a complete recovery and is in good health at the present time, over twelve years since the treatment was begun. Case No. 348 in Bone Sarcoma Registry.

C. S., a male, aged 39 years. Malignant tumor involving nearly one-half of the shaft

of the tibia; no new bone formation. Patient referred to me by Dr. John H. Gibbon



Fig. 22 Another film of Case 12, made two months after Figure 21

in April, 1917. Biopsy performed; tumor pronounced a highly malignant osteogenic sarcoma by Dr. Ewing, with which diagnosis the Bone Sarcoma Registry (see Case No. 183) concurred. From March to May patient received three radium pack treatments and systemic toxins. Tumor apparently disappeared. Toxins kept up until August, 1917, when the patient went on his vacation. On his return two months later (October) examination showed extensive metastases in the inguinal, femoral, and iliac glands. A gland was removed and pronounced sarcoma. Three radium pack treatments given from October to December, 1917; toxin treatment resumed and kept up for a period of two and one-half years (did not interfere with the patient's usual routine of life). All evidence of the disease disappeared and the patient remains in good condition, fourteen years since the treatment was begun.

While this case was registered in 1917 as an osteogenic sarcoma, I have come to the conclusion that it should have been classified as an endothelioma, for the following reasons: it was a tumor of the shaft; there was no new bone formation; the tumor as well as the metastases to the regional glands responded promptly to toxins and radium.

H. S. (Case 11), a male, aged 8 years. Endothelial myeloma of the shaft of the fibula, with extensive metastases in the femoral, inguinal, and iliac glands, and probably in the lungs. Diagnosis confirmed by microscopic examination. Toxin treatment given for three months after amputation. One radium pack treatment over groin only. Patient made a complete recovery and is still well, nearly eleven years since the treatment was begun. Case No. 267 in Bone Sarcoma Registry.

G. M., a male, aged 9 years, patient of Dr. George B. Packard, of Denver, Colorado. Sarcoma of upper third of shaft of femur following a recent trauma. Tumor

rapidly growing; had clinical and roentgenographic appearances of endothelioma; inoperable. Patient emaciated and bed-ridden when toxin treatment was begun by Dr. Packard. Complete recovery; no evidence of disease at present, more than ten years after beginning of treatment.

R. H., a male, aged 36 years. Extensive tumor involving middle and upper thirds of shaft of femur following a recent trauma; pathologic fracture; complete destruction of five inches of bone. Roentgenogram of chest suspicious of pulmonary metastasis. Treated with Coley's toxins directly into the tumor and one application of radium pack. Toxins kept up for eight months. Marked diminution in size of tumor; reunion of bone. All evidence of disease disappeared. Patient has a useful limb and for the past eleven years has been carrying on his regular work in a machine factory; is still well, at present over thirteen years since the treatment was begun. Case No. 210 in Bone Sarcoma Registry.

A. G., a male, aged 19 years. Endothelioma involving two-thirds of shaft of femur, with extensive multiple metastases. Original diagnosis (1902), small round-cell sarcoma. Apparent cure by Coley's toxins, after failure of X-ray treatment. Patient had been well ten and one-half years when a malignant tumor (sarcoma and epithelioma) developed in the thigh at the site of an old roengen-ray dermatitis. For full report of this case see *Annals of Surgery*, April, 1913, LVII. Diagnosis in this case confirmed by Dr. E. K. Dunham, Dr. William H. Welch, and Dr. James Ewing.

G. B. (Case 9), a male, aged 31 years. Multiple metastases to bones and soft parts following amputation for sarcoma of tibia in September, 1925. Complete recovery under toxins alone. Patient well at present, more than five years since treatment was begun. Toxins were continued at my suggestion during 1927 and 1928. (See

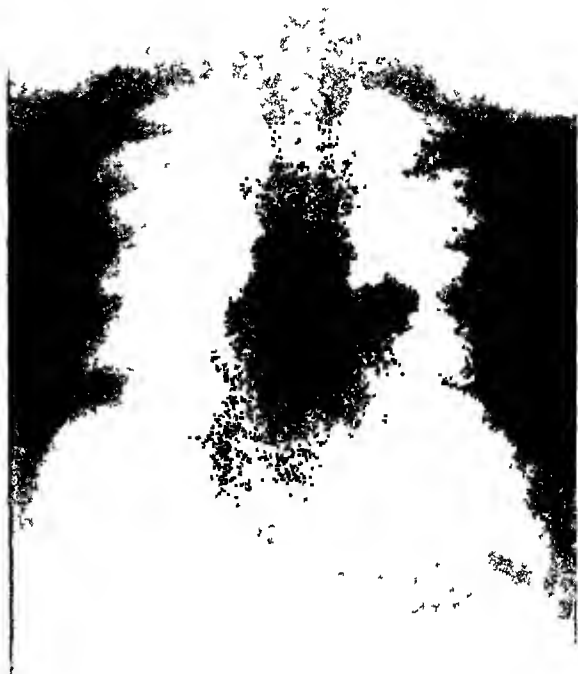


Fig. 23. Another film of Case 12, showing pulmonary metastasis (November, 1926)

case of Dr. S. L. Christian and Dr. L. A. Palmer in *Military Surgeon*, July, 1927, and *American Journal of Surgery*, February, 1928.) Bone Sarcoma Registry Case No. 1143: Ewing's sarcoma.

#### EARLIER RESULTS

Before closing, I should like to say a word about our early results. In his invitation to the Bone Sarcoma Symposium (Baltimore, September, 1930), Dr. Bloodgood, in a few introductory remarks, stated: "The records of more than three thousand cases of bone diseases and bone tumors which have accumulated in the Surgical Pathological Laboratory of the Johns Hopkins Hospital and University for the last forty years show that up to 1913 there was not a single verified case of sarcoma (cancer of bone) cured by any treatment."

In reviewing our earlier series treated at the Memorial Hospital and the Hospital for Ruptured and Crippled prior to 1913, I find





Fig 24 Another film of the chest of Case 12, made March 21, 1927

they include 19 cases of bone sarcoma in which the patients have recovered and remained well for from six to thirty-four years; fifteen of these cases have been well for from ten to thirty-four years. In every case a microscopic examination was made by one of the leading pathologists of the country; eight of the lesions were endotheliomas and the rest osteogenic sarcomas.

The only difference in the methods of treatment employed in our group of cases and in that of the Johns Hopkins Hospital and University is that in every one of the recoveries mentioned the toxins of erysipelas and *Bacillus prodigiosus* were used, either alone or in connection with surgery.

#### ETIOLOGY

As regards the etiology of endothelial myeloma, Ewing<sup>7</sup> states (p 100): "We have not the slightest conception of how or

why the tumors develop. The febrile period in the beginning strongly suggests that an infectious agent may be connected with it, as it is probably connected with lymphosarcoma. I still remain of the opinion that this is a specific disease of bone. With a lack of evidence of some other origin and nature of the tumor it seems best to retain the designation of endothelial myeloma."

While a discussion of the etiology of endothelial myeloma would lead one into the difficult and obscure field of the etiology of malignant tumors in general, I should like to state that, in my opinion, this type of tumor has many features that point very strongly to an extrinsic, that is to say, a microbic cause. These features are: (1) the frequency with which antecedent local trauma is associated with the development of the tumor; (2) the close similarity to osteomyelitis both clinically and roentgenologically, and oftentimes its histological appearance makes it difficult to differentiate it from chronic osteitis or osteomyelitis; (3) its frequent association with rise of temperature ( $101^{\circ}$  to  $104^{\circ}$ ).

While it is true that a history of trauma is found in other types of bone tumors, and, to a lesser degree, in malignant tumors of the soft parts, it shows a rather high percentage, about 50, in endothelioma as well as in osteogenic sarcoma. It is now generally recognized by courts and industrial compensation commissions throughout the world, that antecedent local trauma may be an important causative factor in the development of malignant tumors. No satisfactory explanation of this causative influence has been possible except on the theory that bone sarcomas or malignant tumors in general are due to some extrinsic or microbic cause. If this is granted the explanation is easy: the trauma simply produces a local area of lowered resistance or a favorable soil for the development of the micro-organism which has hitherto been present in the

<sup>7</sup>Proc. New York Path. Soc., January-May, 1924, XXIV, 93

tissues but quite harmless. Having once gained a foothold, it immediately produces a proliferation of cells, resulting in the formation of a malignant tumor. We know this is true as regards a number of infectious diseases, for example, tuberculosis of bone, or osteomyelitis.

During the past year, Dr. Richard F. Berg, of Portland, Oregon, the holder of the Gibney Memorial Fellowship of the Hospital for Ruptured and Crippled, has been conducting, under my direction, a line of research work on the experimental production of bone tumors in chickens by inoculations of dried Rhode Island Red endothelioma-virus obtained from the laboratory of Dr. Murray, of the Imperial Cancer Research Fund, London. Berg not only repeated the experiments of Connor, of San Francisco,<sup>8</sup> *i.e.*, producing typical endotheliomas in the tibiae of young chickens, but, by using fresh tumor material for a subsequent series of inoculations, he was finally able to produce five different types of bone tumors having all the clinical, roentgenologic, and microscopic appearances of the different types of bone tumors found in man.

These results I believe to be of extreme importance. If it is possible to produce the different varieties of malignant tumors by a single micro-organism or living virus, then one of the main objections of the pathologists and bacteriologists to the extrinsic origin of cancer has been removed. They have frequently asserted that to assume cancer is caused by a micro-organism entails the assumption of a different micro-organism for the different varieties of malignant tumors.

#### CONCLUSIONS

1. Endothelial myeloma, or Ewing's sarcoma, while usually the most malignant

<sup>8</sup>Connor, Charles L.: Experimental Sarcoma of Bone. Arch Surg, November, 1929, XIX, 794.



Fig. 25. Specimen removed, Case 12.

of all types of bone tumor, is both highly radiosensitive and likewise responsive to the toxins of erysipelas and *Bacillus prodigiosus*. For this reason we are justified in trying conservative treatment for a limited period before resorting to amputation.

2. Although a very considerable number of cases have been treated by primary radiation alone, or radiation combined with surgery (34 cases in our own series), so far there has been but one five-year cure, and, unfortunately, in this case there was no microscopic examination to verify the diagnosis.

3. A careful analysis of the end-results of different methods of treatment would

seem to warrant us in regarding systemic treatment with the toxins of erysipelas and *B. prodigiosus* (Coley) combined with local radiation, preferably the radium pack, as the best method of treating a primary operable case of endothelioma of the long bones.

4. If the condition has not shown marked improvement at the end of six or eight weeks, then amputation (or resection) followed by prolonged prophylactic toxin treatment should be seriously considered. Further delay without evidence of improvement may result in the development of metastases, with the loss of all hope of saving the life of the patient.

5. The most significant fact brought out by our statistics is the comparatively large number of inoperable cases that have recovered and remained well for five years or more: four treated with toxins alone, and five treated with toxins and radiation. In no less than six of these cases the condition was not only inoperable but extensive metastases (in two cases in the lungs) had already taken place. Therefore, we believe that few cases of endothelioma of bone should be regarded as entirely hopeless until the patient has been given the benefit of a thorough trial of toxin and radium treatment.

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## OSTEITIS FIBROSA

By FREDERIC J. COTTON, M.D., BOSTON, MASSACHUSETTS

**O**STEITIS fibrosa seems a good subject to discuss in order that we may expose ourselves to a chance of learning something about it. Of course, von Recklinghausen's original book, with its marvellous plates, has to do with museum specimens representing a type, or a stage, of presumably systemic disease, at wide variance from what we see in practice. Whether such cases exist in any considerable number with us may be doubted.

What we see—what I see, at least—may be summarized clinically as—

(a) Multiple irregularly scattered bone involvements, sometimes including skull and ribs; sometimes, but not commonly, with cyst formation.

(b) Involvements of one bone only—an enlargement of the shaft sometimes suggesting the characteristic syphilitic changes—an expansion with little change in density, with disappearance of the marrow cavity.

(c) Rather large cysts, near bone ends, with or without other bone involvement, except near the cyst.

All these types may give spontaneous, or at least easy, fractures, which fractures unite.

(d) Cases, sometimes of rapid development, inescapably linked with trauma, sometimes very prompt in appearance and rapid in progress. The bone picture, in X-ray examination, runs close to Ewing's tumor or the non-suppurative Garré type of osteomyelitis.

Two cases I have seen of this class of slower growth, both due to repeated occupational trauma, showed massive overgrowth, with sclerosis. At operation, both showed ivory bone. One case recovered entirely. The other did equally well for a time, but later showed characteristic Paget's dis-

ease in other bones, and died six years later of early senile changes.

(e) What is called osteitis fibrosa of the small bones, Köhler's disease, Preisser's disease, Kienböck's disease, and the rest. The same thing occurs not rarely—though less often than Speed thinks—after fractures of the carpal bones.

There should be a pathologic picture characteristic of fibrous osteitis—there is not!

The cases occurring in carpal or tarsal bones show atrophy, fibrosis, fatty changes, vague unvalled cysts. Obviously, one would say, the result of defective circulation, post-traumatic.

But there is a "catch" to this!

Operate on one of these cases—take out a degenerate semilunar, let us say—and there is *uniformly* a reaction entirely different from that seen when one removes a *dislocated* semilunar—an *inflammatory* reaction and a slow convalescence.

In the other classes the histological picture, save for the occasional cysts, is absolutely characterless; atrophy and hypertrophy, with fibrosis of the interspaces. And what does this tell? Absolutely nothing! One can get just the same slides in a case of Paget's disease. One can get the same thing, absolutely indistinguishable, in parts of a bone with staphylococcus infection (proved) in the vicinity. One gets *nearly* the same thing, microscopically, in the vicinity of giant-cell growths, and *quite* the same thing about the cysts and the fibrosed repair masses that unquestionably are the end-result of giant-cell growths—G. Barrie's hemorrhagic osteomyelitis.

I wonder if we might not do well to cease talking about osteitis fibrosa as a disease, and recognize that the changes reported by the pathologist as osteitis fibrosa mean, not a specific disease at all, but merely evidence

that bone reacts to a *variety of stimuli* by the same sort of changes?

Congenital or endocrine, some of the cases may be—probably are. Mayhap lack of our friend Vitamin D may lie back of some of them. Some represent the reaction to trauma—to one or to many traumas—perhaps often by way of hemorrhage.

In some, the reaction involves molecular bone death, and Mallory's "foreign body giant cells" take up their job of eating dead lime. Sometimes—not always—they get so enthusiastic as to make a giant-cell tumor, so called—really an unruly granulation-mass under pressure, a mass that grows until pressure is relieved, then fibroses or encloses a residual cyst.

Or the same histologic picture confronts us as in Paget's disease, which we now class as pre-senile arteriosclerosis, whether primarily of bone or acting by arteriosclerotic disturbance of the parathyroids: just the same picture microscopically, with atrophy or sclerosis, as may be—in patches often.

Cysts and giant-cell tumors are rarer concomitants of Paget's disease—malignant degenerations are more common.

The point is that the single-bone osteitis fibrosa and Paget's disease are the same thing, too often, histologically or in the X-ray examination.

So with infections. I have two cases in which the shaft changes were osteitis fibrosa, judged by the X-ray or the microscope, but the clean-up operation showed pin-head abscesses deep in the bone, far away from the overgrowth, which yielded *Staphylococci—aurcus* in one, *albus* in the other.

Accordingly, I do not believe there is any such disease as osteitis fibrosa, but I do believe *fibrosis in bone, with concomitant changes, to be merely the reaction of bone to various stimuli*.

The name "osteitis fibrosa cystica" will probably continue to be used as a convenient catch-all, meaning as little as "arthritis" or

"dyspepsia." The important thing is to be sure of our diagnosis, to be sure we are not dealing with more serious processes. The danger is not, I think, of passing by sarcomas, but of being swept off our feet by the startling pictures that this osteitis fibrosa class sometimes shows. Usually we can discriminate pretty well.

Nevertheless, I am for operation—*radically for operation*—partly because of the chance of mistake, as well as because operative measures may be made of distinct service in many cases of osteitis fibrosa, by removing excess bone, and, in the more acute cases, by checking the spread of the growth, apparently by relieving intra-osseous tension, just as one does with the giant-cell tumors. If one clears away a large share of the overgrowth, or even goes to below normal in reducing bulk, in the cases I have called Class D, post-traumatic, much relief is experienced and the process seems to be checked. Nevertheless, one of the cases I have cited developed minor changes in the other tibia, while one went on to a real, though mild, Paget's disease.

By the way, these are not *atrophic lesions*; quite the reverse, so far as blood supply goes. The operations may even occasion rather startling hemorrhages.

Now as to diagnosis, osteitis fibrosa gives varied pictures.

As between osteitis fibrosa and Paget's disease, we can draw no line—not even that of age.

One used to hear much about "one-bone Paget's" from the X-ray men. I have seen one unquestioned case of one-bone Paget's—one bone only for a long while, at least.

On this matter of differential diagnosis. "osteitis fibrosa or Paget's" is all you care to say about it. Both may show distortion of bone, or overgrowth; both may lead to pathologic fracture. Both show union of such fracture—not promptly, but always union. Both show, or may show, multiple

bone involvement. Both may show skull changes, not dissimilar.

Between the two we have two points, and only two, on which to go:

(1) Paget's occurs—or begins—typically, in unfortunate individuals in the early fifties. In younger persons, we lean towards osteitis fibrosa.

(2) Paget's disease shows, variably, a symmetrical involvement of *both* femurs or *both* tibiae. Irregularly distributed Paget's disease is common enough, and the picture of the "one-bone Paget's" is still met with—and not classified.

The occurrence of skull changes is not conclusive, nor the character of the changes.

Essentially, the differentiation is decided on *clinical* lines. As between osteitis fibrosa and other types, essentially cystic, the question is again one of clinical judgment. I have in mind three cases, all of spontaneous fracture just below the hip. One obviously was the end-result of a giant-cell tumor, another was very similar, but with a good

deal of surrounding bone change; the third presented exactly the same local picture, but with pronounced changes in the skull. All three patients were less than thirty-five, and all, by the way, were individuals of at least average vigor and health. One could hardly consider true Paget's disease in any of this group.

There should be no trouble in diagnosis between giant-cell tumor and osteitis fibrosa, though sometimes there is; but between the cyst, end-result of giant-cell growth, and the fibrous repair of either giant-cell tumor or cyst, especially after a spontaneous fracture has opened up the bone and relieved tension, I repeat, between such cases on the one hand and osteitis fibrosa on the other, there may be real difficulty in coming to a conclusion.

The differential diagnosis between a quiet osteomyelitis of the non-suppurative type or a Brodie's abscess (with the not uncommon pale and ill-marked picture of the bone-absorption area) and osteitis fibrosa may well be difficult.

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# RELATION BETWEEN HISTOLOGIC STRUCTURE AND PROGNOSIS IN SARCOMA OF SKIN AND FASCIA

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COMPARATIVELY little attention has been given to any relationship that may exist between histologic structure and prognosis in sarcoma. Broders (1), through many publications, has proposed a system of grading carcinomas. Plaut (2), in 1927, published a general review of the subject of histologic prognosis. He quotes Virchow (3) as stating that malignancy in sarcoma cannot be decided according to any fixed rule, that one must take into account the individual as well as the organ involved. The review in general deals with carcinomas, and, after summarizing the opinions of nearly all who have expressed themselves on the relationship between structure and ultimate result, Plaut concludes: "I do not consider the time ripe, however, to advocate the method of histologic prognosis for practical purposes." Reimann (4) undertook a detailed histologic analysis of 100 cases of cancer of the breast, and compared the theoretical prognoses thus indicated with the actual result as determined through follow-up records. Since the theoretical prognosis proved to be right in only 50 per cent of the cases he reaches the conclusion that "the grading of a tumor for the individual patient is impossible at present." Recently MacCarty (5) has stated that "any system of microscopic grading of cancer should not alone be of accurate clinical value without taking many other factors into consideration," and that "at present all grading of cancers should be considered in the investigative or experimental stage."

The object of the study herein reported was to determine what, if any, relationship might exist between histologic structure and

clinical result in the group of malignant mesoblastic neoplasms (sarcomas, including types commonly designated endotheliomas), exclusive of those of bone. The material was derived entirely from the microscopic sections and clinical histories, including follow-up records, on file in the Surgical Pathological Laboratory of the Johns Hopkins University. This report is based on the first 30 consecutive cases of which both microscopic sections and follow-up records were available.

In analyzing the sections, the degree of cellularity, the relative number of cells having nuclei abnormal in size, and the relative number of nuclei in mitotic division were given numerical values. For the degree of cellularity, these ranged from "0" for a cellularity equal to that of normal subepidermal connective tissue, to "3," for the density of cells in a lymphosarcoma. If no cells had nuclei larger or smaller than normal, abnormal variation in size of nuclei was recorded as "0"; if a moderate number of such cells were observed, a value of "1" was given, and "2" if this feature was marked. Similarly, a "0" recorded that few or no mitotic figures were observed, a "1" that a moderate number were present, and "2" that there were many. The term "malignancy index" was arbitrarily chosen to express the sum of the numerical values of the cellularity, nuclear variation in size, and mitosis for each case.

The 30 cases were then divided into two groups: one, in which the ultimate clinical result was regarded as favorable; the other, as unfavorable. The results are seen in Tables I and II.

TABLE I. CASES WITH FAVORABLE CLINICAL RESULT

| P. N.<br>J. H. H. | Type<br>and<br>location                    | Race | Sex | Age at onset | Pre-operative duration | Operation   | Cellularity | Abnormal variation in size of nuclei | Mitosis | Malignancy index | Clinical result   |
|-------------------|--|------|-----|--------------|------------------------|---|-------------|--------------------------------------|---------|------------------|---|
| 169               | Fibrospindle-cell, upper lip               | W    | F   | 12           | 11 yrs.                | Complete excision                                   | 1           | 0                                    | 0       | 1                | Well, 1 yr.; 10 yrs., not heard from                        |
| 290               | Spindle- and round-cell, floor of mouth    | W    | M   | 48           | 9 mos.                 | Jaw, with symphysis and one-half of tongue, excised | 2           | 1                                    | 0       | 3                | Dead, apoplexy, 5 yrs. 8 mos.                               |
| 843               | Spindle-cell, foot                         | W    | M   | 24           | .....                  | Excision  | 2           | 0                                    | 0       | 2                | Paralysis, right side, 20 yrs. later                        |
| 1274              | Fibrospindle-cell, axilla                  | W    | F   | 34           | 3 mos.                 | Incomplete excision                                 | 0           | 0                                    | 0       | 0                | No recurrence, 16 yrs.                                      |
| 1308              | Pannoma, subcutaneous, shoulder            | C    | M   | 45           | 2 yrs.                 | Complete excision                                   | 2           | 0                                    | 0       | 2                | Dead, 2 yrs., pneumonia; no indication of tumor involvement |
| 1656              | Spindle-cell, temporal fossa               | W    | F   | 66           | 2 yrs.                 | Radical, with cervical glands                       | 1           | 1                                    | 1       | 3                | Well, 7 yrs.  |
| 1867              | Lymphangiosarcoma, forearm, inter-muscular | C    | F   | 8            | 10 yrs.                | Complete excision                                   | 2           | 0                                    | 0       | 2                | Well, 16 yrs.   |
| 2783              | Spindle- and round-cell, skin, face        | C    | M   | 54           | 12 yrs.                | Excision, with partial parotid                      | 1           | 0                                    | 0       | 1                | Dead, apoplexy, 5½ yrs.                                     |
| 4751              | Fibrospindle-cell, skin, thigh             | W    | F   | 25           | 10 yrs.                | Excision, complete                                  | 1           | 0                                    | 0       | 1                | Well, 11 yrs.   |
| 4762              | Fibrospindle-cell, skin, chest             | W    | M   | 37           | 5 yrs.                 | Complete excision                                   | 1           | 1                                    | 0       | 2                | Well, 12 yrs.   |
| 5112              | Fibrospindle-cell, heel, fascia            | W    | M   | 20           | 4 yrs.                 | Amputation foot; glands in groin                    | 2           | 1                                    | 0       | 3                | Well, 12 yrs.   |
| 5428              | Fibromyxosarcoma, nerve sheath, coccyx     | W    | F   | 18           | 3 yrs.                 | Removal of coccyx; curettement of tumor             | 0           | 0                                    | 0       | 0                | Question of recurrence, 19 yrs later                        |
| 5397              | Fibrospindle-cell, skin, lip               | W    | F   | 45           | .....                  | Local excision                                      | 3           | 0                                    | 0       | 3                | Well, 9 yrs.  |



TABLE II. CASES WITH UNFAVORABLE CLINICAL RESULT

| F.<br>H.<br>N. | Type<br>and<br>location                          | Race | Sex | Age at onset | Pre-operative duration | Operation                                     | Cellularity |   |   |   | Abnormal variation in size of nuclei |   |   |   | Mitosis |   |   |   | Malignancy index |   |   |   | Clinical result                                       |
|----------------|--|------|-----|--------------|------------------------|---|-------------|---|---|---|--------------------------------------|---|---|---|---------|---|---|---|------------------|---|---|---|---|
|                |  |      |     |              |                        |   |             |   |   |   |                                      |   |   |   |         |   |   |   |                  |   |   |   |   |
| 637            | Perithelial angiosarcoma, skin, chest            | W    | M   | 39           | 4 yrs.                 | Complete excision                             | 3           | 1 | 1 | 5 | 3                                    | 1 | 1 | 5 | 3       | 1 | 1 | 5 | 3                | 1 | 1 | 5 | Dead, int. metastases, 11 mos.                        |
| 708            | Spindle- and round-cell, back                    | W    | F   | 41           | 2 yrs.                 | Excision                                      | 2           | 1 | 1 | 4 | 2                                    | 1 | 1 | 4 | 2       | 1 | 1 | 4 | 2                | 1 | 1 | 4 | Dead, int. metastases, 1½ yr.                         |
| 1020           | Small round-cell, dura                           | C    | M   | 45           | .....                  | .....   | 3           | 0 | 0 | 3 | 3                                    | 0 | 0 | 3 | 3       | 0 | 0 | 3 | 3                | 0 | 0 | 3 | Dead, 1½ yr.  |
| 1224           | Spindle- and round-cell, skin, leg               | W    | M   | 53           | 3 mos.                 | Complete excision, with muscle, wide margin   | 2           | 1 | 1 | 4 | 2                                    | 1 | 1 | 4 | 2       | 1 | 1 | 4 | 2                | 1 | 1 | 4 | Dead, 7 mos., cause unknown                           |
| 2270           | Perithelial angiosarcoma, lumbar fossa           | W    | F   | 25           | 4 mos.                 | Excision, with rib, muscle, and part vertebra | 2           | 1 | 0 | 3 | 2                                    | 1 | 0 | 3 | 2       | 1 | 0 | 3 | 2                | 1 | 0 | 3 | Dead, 6 mos., question of tuberculosis or metastasis  |
| 2124           | Spindle- and round-cell, lumbar region           | W    | M   | 54           | 1½ yrs.                | Exploratory, inoperable                       | 2           | 1 | 1 | 4 | 2                                    | 1 | 1 | 4 | 2       | 1 | 1 | 4 | 2                | 1 | 1 | 4 | Dead, 6 mos.  |
| 2547           | Fibrospondylomyxosarcoma, lumbar fossa           | W    | M   | 53           | 2 mos.                 | Partial excision                              | 0           | 0 | 0 | 0 | 0                                    | 0 | 0 | 0 | 0       | 0 | 0 | 0 | 0                | 0 | 0 | 0 | Dead, 2 mos.  |
| 2886           | Spindle-cell, skin, forehead                     | W    | M   | 32           | 2 yrs.                 | Excision, with lymphatics                     | 2           | 1 | 1 | 4 | 2                                    | 1 | 1 | 4 | 2       | 1 | 1 | 4 | 2                | 1 | 1 | 4 | Dead, 1 yr., internal metastases                      |
| 3008           | Lymphangiosarcoma, thigh                         | W    | F   | 59           | 4 wks.                 | Amputation below trochanter                   | 3           | 1 | 1 | 5 | 3                                    | 1 | 1 | 5 | 3       | 1 | 1 | 5 | 3                | 1 | 1 | 5 | Dead, 5 or 6 mos.                                     |
| 3016           | Lymphangiosarcoma, leg, intermuscular            | W    | F   | 9            | 7½ mos.                | Amputation, knee, glands along sciatic nerve  | 3           | 1 | 1 | 5 | 3                                    | 1 | 1 | 5 | 3       | 1 | 1 | 5 | 3                | 1 | 1 | 5 | Dead, few mos., metastases                            |
| 3793           | Perithelial angiosarcoma, skin, neck             | W    | F   | 37           | 2 yrs.                 | Excision, with cervical glands                | 2           | 1 | 0 | 3 | 2                                    | 1 | 0 | 3 | 2       | 1 | 0 | 3 | 2                | 1 | 0 | 3 | Dead, 6 mos., recurrence and metastases               |
| 4382           | Fibromyxosarcoma, nerve sheath, popliteal space  | W    | F   | 22           | 1 yr.                  | Excision                                      | 2           | 0 | 0 | 2 | 2                                    | 0 | 0 | 2 | 2       | 0 | 0 | 2 | 2                | 0 | 0 | 2 | Two recurrences; dead, 5 yrs.                         |
| 4847           | Small round-cell, eyelid and cheek               | W    | F   | 4            | 6 wks.                 | Complete excision, with enucleation of eye    | 2           | 1 | 1 | 4 | 2                                    | 1 | 1 | 4 | 2       | 1 | 1 | 4 | 2                | 1 | 1 | 4 | Recurrence; dead 4½ mos.                              |
| 4904           | Spindle- and round-cell, intermuscular, shoulder | W    | M   | 21           | 6 mos.                 | Amputation arm, scapula, and half clavicle    | 1           | 1 | 0 | 2 | 1                                    | 1 | 0 | 2 | 1       | 1 | 0 | 2 | 1                | 1 | 0 | 2 | Dead, 3 mos., internal metastases                     |
| 4951           | Round-cell, skin, thigh                          | W    | F   | 42           | 3 yrs.                 | Excision                                      | 2           | 1 | 0 | 3 | 2                                    | 1 | 0 | 3 | 2       | 1 | 0 | 3 | 2                | 1 | 0 | 3 | Dead, 3 mos.; retroperitoneal metas. (explor. lapar.) |
| 5604           | Endothelioma, lower jaw                          | W    | M   | 19           | 1 yr.                  | Excision, jaw                                 | 2           | 1 | 0 | 3 | 2                                    | 1 | 0 | 3 | 2       | 1 | 0 | 3 | 2                | 1 | 0 | 3 | Recurrence and metastases, 1 yr.; dead, 3 yrs.        |
| 5866           | Lymphangio-endothelioma, thigh                   | C    | F   | 34           | 4½ mos.                | Complete excision                             | 2           | 1 | 0 | 3 | 2                                    | 1 | 0 | 3 | 2       | 1 | 0 | 3 | 2                | 1 | 0 | 3 | Recurrence and metastases; dead, few mos.             |

## COMMENT AND CONCLUSIONS

It is seen that the average malignancy index of the 13 cases having a favorable clinical result is 1.7, while the average malignancy index of the 17 cases having an unfavorable clinical result is 3.4, yet in individual cases of either series the relationship of malignancy index to clinical result is not constant. Thus, Case 5.112, a fibrospindle-cell sarcoma of the heel (soft parts), with a malignancy index of 3, was of four years' pre-operative duration, and was well, with no recurrence, when last heard from, twelve years after operation; while Case 2,547, a fibrospindlemyxosarcoma, intermuscular, of the lumbar region, in which death occurred four months after clinical onset, presented a malignancy index of 0. The unreliability of using histologic criteria in estimating prognosis in individual cases is here manifest.

All seven pure fibrospindle-cell sarcomas of this series fall into the favorable result group. Of the pure spindle-cell sarcomas, two are in the favorable group and one in the unfavorable. Four of the six spindle- and round-cell sarcomas, both fibrospindlemyxosarcomas, all three small round-cell sarcomas, all three hemangiosarcomas, and three of the four lymphangiosarcomas are in the unfavorable result group. The two

endotheliomas are divided between the two groups.

The average pre-operative clinical duration in the favorable result group is 5.4 years; in the unfavorable result group it is 1.2 year.

In the favorable result group the average age at onset is 33.5 years; in the unfavorable result group it is 34.6 years.

Thanks are extended to Dr. Joseph C. Bloodgood, the use of whose records, materials, and laboratory facilities made this study possible.

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# A STUDY OF BONE TUMORS AMONG EX-SERVICE MEN

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THE clinical incidence of bone sarcoma has been estimated at 1 case per 100,000 of the living population (1); accordingly, there are approximately 1,200 persons with bone sarcoma alive at any one time in the United States. With a living World War veterans' population estimated at 4,330,598, the number of cases of bone sarcoma among ex-service men is small. However, on account of the prevalence of other types of bone tumors, and the various inflammatory as well as degenerative diseases of bones, it is desirable that the differential diagnosis of the different forms of bone disease, as well as their proper treatment, be thoroughly understood.

Thanks to the untiring efforts and labor of such men as Codman, Bloodgood, and Ewing, and as the result of the establishment of the Registry of Bone Sarcoma, data regarding this subject have been compiled and have been made available to the profession. The clinical, X-ray, and pathological research work done has resulted in a more scientific, a more rational as well as a more practical viewpoint regarding the classification, criteria for diagnosis, treatment, and the prognosis of bone tumors.

The present study is the result of an analysis of the histories of 45 cases of bone tumor among ex-service men. Some of the patients incurred the disability during the World War, others soon after their discharge from the military service. These patients were treated in Government and civilian hospitals. There was a lack of uniformity of certain of the data in the clinical histories of these cases, so that much of the information was difficult of statistical treatment. Nevertheless, in spite of this fact, the study reveals a considerable amount of im-

portant information concerning the subject under consideration.

## CLASSIFICATION OF BONE TUMORS

The classification and the criteria for diagnosis used in this study are those recommended by the Committee of Registry of Bone Sarcoma. A review of Table I shows that 38, or 84.5 per cent, of the total number were cases of osteogenic sarcoma; 5, or 11.1 per cent, were benign giant-cell tumors; there was one case of unclassified sarcoma (extra-periosteal), and one case of benign osteogenic tumor.

The cases were also classified according to whether they were central or periosteal in origin. It was found that 2 of the bone tumors were central in origin, while 17 were periosteal in origin. In 26 cases the origin of the tumor was not recorded.

TABLE I.—CLASSIFICATION OF FORTY-FIVE CASES OF BONE TUMOR

| Type of bone tumor                      | Number | Percentage |
|---|--------|------------|
| Osteogenic sarcoma                      | 38     | 84.5       |
| Unclassified sarcoma (extra-periosteal) | 1      | 2.2        |
| Benign giant-cell tumor                 | 5      | 11.1       |
| Benign osteogenic tumor                 | 1      | 2.2        |
| Total                                   | 45     | 100.0      |

## HISTOPATHOLOGY

It was previously indicated that these 45 cases were under treatment in a number of Government and civilian hospitals, so that the classification of the bone tumor, the criteria for diagnosis, and the microscopic interpretation of the stained tissue specimens were varied, making it difficult to arrive at an agreement of the divergent opinions for purposes of statistical analysis. However, in spite of these difficulties, the cases were

properly classified, both according to clinical criteria and upon the basis of cell structure.

According to the type of cells found in the stained sections, ten of the 45 cases were of the spindle-cell type of sarcoma; eight were of the mixed-cell variety; six of the cases of bone tumor showed a predominance of giant cells, one of these being an osteogenic sarcoma while five were cases of benign giant-cell tumor; one of the cases showed the characteristic histology of a benign osteogenic tumor, and in twenty cases the type of cell was either unrecorded or was described in a manner which made it impossible to properly classify the cellular structure. (See Table II.)

more, the members of the family possessing the malignant-disease-susceptibility do not all possess the same degree of strength of the malignant-disease-predisposition: in some members of the family the malignancy may appear early, and in other members of the same family malignant-disease-susceptibility may not show itself until very late in life.

In addition to this hereditary susceptibility to malignant disease, there are two other factors which play important rôles in the development of malignancy: (1) organ or tissue predisposition; (2) the extrinsic factor (irritation), which may not always be present.

TABLE II.—HISTOPATHOLOGY OF FORTY-FIVE CASES OF BONE TUMOR

| Type of bone tumor                      | Type of Cell |       |       |                    |              | Total |
|---|--------------|-------|-------|--------------------|--------------|-------|
|   | Spindle      | Mixed | Giant | Bone and cartilage | Unclassified |       |
| Osteogenic sarcoma                      | 9            | 8     | 1     |                    | 20           | 38    |
| Unclassified sarcoma (extra-periosteal) | 1            |       |       |                    |              | 1     |
| Benign giant-cell tumor                 |              |       | 5     |                    |              | 5     |
| Benign osteogenic tumor                 |              |       |       | 1                  |              | 1     |
| Total                                   | 10           | 8     | 6     | 1                  | 20           | 45    |

#### FAMILIAL OR HEREDITARY HISTORY OF MALIGNANCY

An attempt was made to ascertain whether or not there was a familial or hereditary history of malignancy in general or of sarcoma in particular among the cases studied. A review of the histories elicited the fact that in sixteen instances there was a negative history, and in twenty-nine instances the information on the subject was unrecorded; in not a single case was there a positive family history of either malignancy or sarcoma.

The consensus of modern opinion regarding the etiology of malignancy is that there is a general constitutional malignant-disease-susceptibility which is inherited, and that this quality may manifest itself in different forms in different families. Further-

#### THE RÔLE OF TRAUMA

In reviewing the clinical records of the 45 cases it was found that 13, or 28.9 per cent, gave a positive history of trauma; in one case there was a definite negative history, and in 31, or 68.9 per cent, of the cases the clinical records gave no evidence one way or the other.

The relationship of trauma to the development of bone sarcoma is not thoroughly understood. The hypothesis formulated to explain this relationship is based upon the fact that when the growing organism reaches its adult age or the terminal stage of physical development, the growth tendency of the tissue cells is interfered with so that no advanced growth is possible. This phenomenon of the tissue cells is known as "growth restraint."

Trauma, with the consequent necessity of repair, leads to a temporary elimination of the quality of "growth restraint," with resulting acceleration of regenerative processes and a multiplication of the mesoblastic cellular elements. It must be understood that not all cases of bone sarcoma are preceded by trauma nor are all traumas of bone followed by the development of sarcoma. The small percentage of cases of bone fracture followed by malignancy confirms the latter view and is a strong argument against the opinion that bone sarcoma is invariably preceded by trauma.

What, then, is essential for a sarcoma to develop after a bone has been traumatized? According to the same hypothesis, which is based upon both clinical data of human cases and work upon animals, it is necessary for the subject to possess a constitutional susceptibility to malignant disease—an inherited property. In addition, there must be a tissue or organ predisposition to malignant disease. The latter is a common observation in cases of bone sarcoma in which it is found that certain particular bones are more susceptible than are others.

In the course of the study an attempt was made to learn the length of time elapsing between the trauma and the first symptoms or signs of bone tumor in the thirteen cases giving a positive history of injury. This information is recorded in Table III. It will

be noted that the time varied from less than one month to as long as forty months. In this connection it must be pointed out that the date of the first diagnosis of bone tumor is not the date of the inception of the growth. The latter is, at first, a histologic phenomenon and cannot be demonstrated clinically. When the malignant disease is recognized, either by subjective or objective symptoms or signs, it has attained an advanced stage and has progressed beyond the period of inception.

#### AGE INCIDENCE

The age of the 45 ex-service patients at the time of the diagnosis of bone tumor may be noted by referring to Table IV. Taking the group as a whole, it is found that 19 years was the minimum age at the time of diagnosis; 32 years was the maximum age, and 24.7 years was the average age.

Of the thirteen living cases, the youngest was 31 years of age (on November 1, 1930, the date of this study); the oldest was 42 years of age, and the average age of the living group was 37 years.

Of the 32 patients who had died, the youngest was 22 years of age; the oldest was 34 years, and the average age of the group was 27.4 years.

#### DISTRIBUTION OF BONE TUMORS

Kolodny (1) found that the bone most frequently affected with osteogenic sarcoma

TABLE III.—LENGTH OF TIME BETWEEN TRAUMA AND FIRST SYMPTOMS OR SIGNS OF BONE TUMOR

|                 | Osteogenic sarcoma |            |            |                   | Benign giant-cell tumor | Total |
|-----------------|--------------------|------------|------------|-------------------|-------------------------|-------|
|                 | Spindle cell       | Mixed cell | Giant cell | Cell unclassified |                         |       |
| 1 month or less |                    |            |            | 1                 | 1                       | 2     |
| 3 months        |                    | 1          |            |                   |                         | 1     |
| 4 months        |                    |            |            | 1                 | 1                       | 2     |
| 5 months        |                    |            | 1          |                   |                         | 1     |
| 6 months        | 1                  |            |            | 1                 |                         | 2     |
| 11 months       |                    | 1          |            |                   |                         | 1     |
| 13 months       |                    | 1          |            | 1                 |                         | 2     |
| 24 months       |                    | 1          |            |                   |                         | 1     |
| 40 months       |                    |            |            | 1                 |                         | 1     |
| Total           | 1                  | 4          | 1          | 5                 | 2                       | 13    |

TABLE IV.—MINIMUM, MAXIMUM, AND AVERAGE AGE AT (a) TIME OF DIAGNOSIS, (b) ON NOVEMBER 1, 1930, IN LIVING CASES, AND (c) AT DEATH, IN PATIENTS WHO DIED

|   | At time of diagnosis |             |             |             | As of November 1, 1930<br>(living cases) |             |             |             | At time of death<br>(patients who had died) |             |             |             |
|---|----------------------|-------------|-------------|-------------|--|-------------|-------------|-------------|---|-------------|-------------|-------------|
|   | No. cases            | Minimum age | Maximum age | Average age | No. cases                                | Minimum age | Maximum age | Average age | No. cases                                   | Minimum age | Maximum age | Average age |
| Osteogenic sarcoma                      | 38                   | 19          | 32          | 24.9        | 7  | 31          | 42          | 38.0        | 31  | 22          | 34          | 27.4        |
| Unclassified sarcoma (extra-periosteal) | 1                    | 20          | 20          | 20.0        |  |             |             |             | 1   | 29          | 29          | 29.0        |
| Benign giant-cell tumor                 | 5                    | 21          | 31          | 24.8        | 5  | 33          | 42          | 36.0        |   |             |             |             |
| Benign osteogenic tumor                 | 1                    | 23          | 23          | 23.0        | 1  | 35          | 35          | 35.0        |   |             |             |             |
| Total                                   | 45                   | 19          | 32          | 24.7        | 13                                       | 31          | 42          | 37.0        | 32  | 22          | 34          | 27.4        |

is the femur; the next most frequently involved bones are the tibia and humerus. Geschickter and Copeland (2), in a study of giant-cell tumors, found that the femur, hu-

merus, and tibia were the most frequently affected bones.

A study of Table V shows that in the group of 45 cases of bone tumor the left

TABLE V.—BONE INVOLVED

| Bone involved                                    | Osteogenic sarcoma |            |            |                   | Unclassified sarcoma (extra-periosteal) | Benign giant-cell tumor | Benign osteogenic tumor | Total |
|--|--------------------|------------|------------|-------------------|---|-------------------------|-------------------------|-------|
|  | Spindle cell       | Mixed cell | Giant cell | Cell unclassified |   |                         |                         |       |
| Right femur                                      |                    |            | 1          | 3                 |   | 3                       |                         | 7     |
| Left femur                                       | 4                  | 3          |            | 6                 |   |                         | 1                       | 14    |
| Right tibia                                      | 1                  | 1          |            | 4                 |   |                         |                         | 6     |
| Left tibia                                       |                    | 2          |            | 2                 |   | 1                       |                         | 5     |
| Right humerus                                    | 1                  |            |            |                   |   |                         |                         | 1     |
| Left humerus                                     | 1                  |            |            |                   |   |                         |                         | 1     |
| Right fibula                                     | 1                  |            |            |                   |   |                         |                         | 1     |
| Right tibia and right fibula                     |                    |            |            | 1                 |   |                         |                         | 1     |
| Left tibia and left fibula                       |                    | 1          |            |                   |   |                         |                         | 1     |
| Right tibia and right os calcis                  |                    | 1          |            |                   |   |                         |                         | 1     |
| Right humerus, right ulna, and right radius      |                    |            |            |                   | 1                                       |                         |                         | 1     |
| Left humerus and left scapula                    |                    |            |            |                   |   | 1                       |                         | 1     |
| Right ilium                                      |                    |            |            | 1                 |   |                         |                         | 1     |
| First metatarsal bone, right                     |                    |            |            | 1                 |   |                         |                         | 1     |
| First cuneiform and first metatarsal bone, right |                    |            |            | 1                 |   |                         |                         | 1     |
| Cuboid bone, left foot                           | 1                  |            |            |                   |   |                         |                         | 1     |
| Third rib, left                                  |                    |            |            | 1                 |   |                         |                         | 1     |
| Total  | 9                  | 8          | 1          | 20                | 1                                       | 5                       | 1                       | 45    |

TABLE VI.—BONES INVOLVED. ALSO SITES OF PREDILECTION

|   | Osteogenic sarcoma |            |            |                   | Unclassified sarcoma (extra-periosteal) | Benign giant-cell tumor | Benign osteogenic tumor | Total |
|---|--------------------|------------|------------|-------------------|---|-------------------------|-------------------------|-------|
|   | Spindle cell       | Mixed cell | Giant cell | Cell unclassified |   |                         |                         |       |
| Right femur:  |                    |            |            |                   |   |                         |                         |       |
| Upper one-third   |                    |            |            |                   |   | 1                       |                         | 1     |
| Middle one-third  |                    |            |            | 1                 |   |                         |                         | 1     |
| Lower one-third   |                    |            | 1          | 1                 |   | 2                       |                         | 4     |
| Unrecorded  |                    |            |            | 1                 |   |                         |                         | 1     |
| Left femur:   |                    |            |            |                   |   |                         |                         |       |
| Upper one-third   |                    |            |            |                   |   |                         | 1                       | 1     |
| Middle one-third  |                    |            |            | 1                 |   |                         |                         | 1     |
| Lower one-third   | 1                  | 3          |            | 5                 |   |                         |                         | 12    |
| Right tibia:  |                    |            |            |                   |   |                         |                         |       |
| Upper one-third   |                    |            |            | 3                 |   |                         |                         | 3     |
| Middle one-third  | 1                  |            |            |                   |   |                         |                         | 1     |
| Lower one-third   |                    | 1          |            |                   |   |                         |                         | 1     |
| Unrecorded  |                    |            |            | 1                 |   |                         |                         | 1     |
| Left tibia:   |                    |            |            |                   |   |                         |                         |       |
| Upper one-third   |                    | 2          |            | 2                 |   | 1                       |                         | 5     |
| Right humerus:  |                    |            |            |                   |   |                         |                         |       |
| Upper one-third   | 1                  |            |            |                   |   |                         |                         | 1     |
| Left humerus:   |                    |            |            |                   |   |                         |                         |       |
| Upper one-third   | 1                  |            |            |                   |   |                         |                         | 1     |
| Right fibula:   |                    |            |            |                   |   |                         |                         |       |
| Upper one-third   | 1                  |            |            |                   |   |                         |                         | 1     |
| Right tibia and right fibula:   |                    |            |            |                   |   |                         |                         |       |
| Unrecorded  |                    |            |            | 1                 |   |                         |                         | 1     |
| Left tibia and left fibula:   |                    |            |            |                   |   |                         |                         |       |
| Lower one-third   |                    | 1          |            |                   |   |                         |                         | 1     |
| Right tibia and right os calcis:  |                    |            |            |                   |   |                         |                         |       |
| Lower one-third, right tibia  |                    | 1          |            |                   |   |                         |                         | 1     |
| Right humerus, ulna, and radius:  |                    |            |            |                   |   |                         |                         |       |
| Lower one-third, right humerus and upper one-third, right radius and ulna |                    |            |            |                   | 1                                       |                         |                         | 1     |
| Left humerus and left scapula:  |                    |            |            |                   |   |                         |                         |       |
| Upper one-third, left humerus   |                    |            |            |                   |   | 1                       |                         | 1     |
| Right ilium   |                    |            |            |                   |   |                         |                         |       |
| Unrecorded  |                    |            |            | 1                 |   |                         |                         | 1     |
| First metatarsal bone, right:   |                    |            |            |                   |   |                         |                         |       |
| Unrecorded  |                    |            |            | 1                 |   |                         |                         | 1     |
| First cuneiform and first metatarsal bone, right                          |                    |            |            |                   |   |                         |                         |       |
| Unrecorded  |                    |            |            | 1                 |   |                         |                         | 1     |
| Cuboid bone, left foot:   |                    |            |            |                   |   |                         |                         |       |
| Unrecorded  | 1                  |            |            |                   |   |                         |                         | 1     |
| Third rib, left   |                    |            |            |                   |   |                         |                         |       |
| Unrecorded  |                    |            |            | 1                 |   |                         |                         | 1     |
| Total   | 9                  | 8          | 1          | 20                | 1                                       | 5                       | 1                       | 45    |

femur was affected fourteen times, and the right femur seven times. The right tibia was affected in six instances and the left tibia in five. The right and left humeri were each affected once

It is thus seen that the femur was affected in 46.7 per cent of the 45 cases, the tibia in 24.5 per cent, and the humerus in 4.4 per cent.

Of the five cases of benign giant-cell

tumor, three were in the right femur, one in the left tibia, and one in the left humerus and left scapula.

#### PORTION OF BONE INVOLVED

Meyerding (3), in a study of a group of cases of sarcoma of bone at the Mayo Clinic, found that the most common sites were in the lower end of the femur, the upper end of the tibia, and the upper end of the humerus. Kolodny (1) states that the bone most frequently involved is the femur and the seat of predilection is in the lower metaphysis of this bone; the second most frequent bone involved is the tibia and the most common portion of the bone affected is the upper end; the humerus is next most frequently involved, and the upper third of the bone is the most common site of the tumor.

Geschickter (4), in a study of a large group of bone tumors, found bone sarcoma most frequent in the lower portion of the femur, the upper portion of the tibia, and the upper portion of the humerus. This observer found giant-cell tumors most frequent in the upper end of the tibia, the lower end of the radius, and the lower end of the femur.

A review of Table VI shows that in the group of 45 cases studied the most frequent site of bone tumor is the lower end of the femur; the next most frequent site is the upper end of the tibia.

The localization of most osteogenic sarcomas about the knee, which is frequently exposed to trauma, causes Kolodny (1) to state that trauma is a definite factor in the causation of this condition.

#### RECURRENCES OR EXTENSIONS

Bone tumors, particularly osteogenic sarcomas, are characterized by the property of invading normal tissues. This fact is illustrated in Table VII, in which it is shown that, of the 45 cases studied, eleven, or 24.4

per cent, gave evidence of an extension or a recurrence of the tumor. It is of interest to know that one case of unclassified sarcoma, five cases of benign cell tumor, and one case of benign osteogenic tumor showed no evidence of extensions or recurrences.

The fact that osteogenic sarcomas will extend or will recur after excision makes it highly desirable that in any operative procedure used in their treatment there must be a complete removal of the affected bone, in order to insure against future recurrence in the stump or in adjacent bones or soft parts.

Table VIII illustrates the bone of origin as well as the site of extension or recurrence of the eleven cases of osteogenic sarcoma under consideration. It is noted that in five instances the recurrence was in the stump; the remaining six cases gave evidence of an extension or recurrence in the bones or tissues adjacent to the site of origin of the sarcoma.

#### METASTASES

Metastatic deposits of osteogenic sarcoma may occur in organs of the abdominal cavity, in the brain, in bones, in the skin, and occasionally in the regional lymph nodes. The most common site of metastasis is the lungs. These metastases usually occur during the first two years after the onset of symptoms of osteogenic sarcoma (1).

The opinion prevails that metastases are spread through the medium of the blood stream, but in isolated instances it has been noted that the lymphatic system was the factor in the spread of the sarcoma.

Table IX shows that, of the 45 cases of bone tumor studied, 25, or 55.6 per cent, showed the presence of metastases. It is of interest to note that one of the cases showing the presence of metastases was an osteogenic sarcoma in which the microscopic study of the sections showed the giant cell to be the predominant type of cell. There



TABLE VII.—TYPE OF BONE TUMOR AND PRESENCE OR ABSENCE OF EXTENSIONS OR RECURRENCES

| Type of bone tumor                      | No. cases having extensions or recurrences | No. cases without extensions or recurrences | Total |
|---|--|---|-------|
| Osteogenic sarcoma:                     |  |   |       |
| Spindle cell                            | 3  | 6   | 9     |
| Mixed cell                              | 3  | 5   | 8     |
| Giant cell                              | 0  | 1   | 1     |
| Cell unclassified                       | 5  | 15  | 20    |
| Unclassified sarcoma (extra-periosteal) | 0  | 1   | 1     |
| Benign giant-cell tumor                 | 0  | 5   | 5     |
| Benign osteogenic tumor                 | 0  | 1   | 1     |
| Total                                   | 11   | 34  | 45    |
| Percentage                              | 24.4                                       | 75.6  | 100.0 |

TABLE VIII.—BONE OF ORIGIN AND SITE OF EXTENSION OR RECURRENCE IN ELEVEN CASES OF BONE TUMOR

| Bone of origin   | Site of extension or recurrence |                                  |                     |                             |            |             |  | Total |
|--|---------------------------------|----------------------------------|---------------------|-----------------------------|------------|-------------|--|-------|
|  | Stump                           | Right scapula and right clavicle | Tissues of left leg | Right femur and bony pelvis | Right foot | Right femur | Chest from first rib to upper border fourth rib and into left lung |       |
| Osteogenic sarcoma                                       |                                 |                                  |                     |                             |            |             |  |       |
| Spindle cell:  |                                 |                                  |                     |                             |            |             |  |       |
| Left femur   | 1                               |                                  |                     |                             |            |             |  | 1     |
| Right fibula   | 1                               |                                  |                     |                             |            |             |  | 1     |
| Right humerus  |                                 | 1                                |                     |                             |            |             |  | 1     |
| Mixed cell:  |                                 |                                  |                     |                             |            |             |  |       |
| Left femur   | 2                               |                                  |                     |                             |            |             |  | 2     |
| Left tibia   |                                 |                                  | 1                   |                             |            |             |  | 1     |
| Cell unclassified:                                       |                                 |                                  |                     |                             |            |             |  |       |
| Left femur   | 1                               |                                  |                     |                             |            |             |  | 1     |
| Right tibia  |                                 |                                  |                     | 1                           |            |             |  | 1     |
| Right ilium  |                                 |                                  |                     |                             |            | 1           |  | 1     |
| First cuneiform, right, and first metatarsal bone, right |                                 |                                  |                     |                             | 1          |             |  | 1     |
| Third rib, left  |                                 |                                  |                     |                             |            |             | 1  | 1     |
| Total  | 5                               | 1                                | 1                   | 1                           | 1          | 1           | 1  | 11    |

were five cases of giant-cell tumor which did not give any evidence of metastasis. The highest incidence of metastasis is noted in the eight cases of mixed cell osteogenic sarcoma, in which six, or 75 per cent, showed the presence of metastatic foci.

A review of Table X shows that the 25

cases of osteogenic sarcoma gave evidence of 48 metastases, which means an average of 1.8 metastatic foci in each case. The most frequent sites were the lungs and the inguinal, axillary, and abdominal lymph nodes. This is of interest inasmuch as the opinion prevails that the lymph nodes are

TABLE IX.—TYPE OF BONE TUMOR AND PRESENCE OR ABSENCE OF METASTASES

| Type of bone tumor                      | No. cases having metastases | No. cases without metastases | Total |
|---|-----------------------------|------------------------------|-------|
| Osteogenic sarcoma:                     |                             |                              |       |
| Spindle cell                            | 6                           | 3                            | 9     |
| Mixed cell                              | 6                           | 2                            | 8     |
| Giant cell                              | 1                           | 0                            | 1     |
| Cell unclassified                       | 12                          | 8                            | 20    |
| Unclassified sarcoma (extra-periosteal) | 0                           | 1                            | 1     |
| Benign giant-cell tumor                 | 0                           | 5                            | 5     |
| Benign osteogenic tumor                 | 0                           | 1                            | 1     |
| Total                                   | 25                          | 20                           | 45    |
| Percentage                              | 55.6                        | 44.4                         | 100.0 |

seldom involved. The liver was involved in four instances. It is also of interest to note that metastases occurred in bones in twelve instances.

#### DIAGNOSTIC SYMPTOMS AND SIGNS

Bloodgood (5) considers localized pain and swelling the predominant symptoms of onset of osteogenic sarcoma. Meyerding (6), in a study of a group of 109 cases of sarcoma of bone, found that the most constant symptom was mild, boring pain; local swelling was also present, as was early evidence of disturbed circulation, such as enlarged veins over the tumor. Meyerding observed that patients continue to be up and around, and were not disabled until either the tumor became large or pathological fracture had occurred. Kolodny (1) found that pain and swelling were the first symptoms noted in approximately one-third of all cases of osteogenic sarcoma. These symptoms were present in the cases studied about one month after a history of injury.

Kolodny (7) holds that the diagnosis of bone sarcoma rests upon a careful consideration of the findings accumulated from all three angles of study, the clinical, roentgenological, and pathological. Occasionally the history and clinical picture will suffice to establish the diagnosis without the necessity of X-ray or histological study. Not infrequently the roentgenogram will sug-

gest the correct diagnosis. In a number of instances even a most careful study of available clinical, X-ray, and histological data will prove insufficient to establish the diagnosis.

In reviewing the diagnostic symptoms and signs recorded in the histories of the group under discussion it was noted that pain and swelling were present in twenty instances, pain alone in seven instances, swelling in six instances. Another symptom or sign noted in the histories was partial or total loss of function.

It was also noted that in nineteen instances the X-ray findings were suggestive of bone tumor. In twenty-six instances there was no record of a roentgenological examination.

#### TREATMENT

Meyerding (6) advises the exploration of the tumor before amputating the limb. He states that many radical operations have been performed and limbs needlessly sacrificed because of failure to explore. He says that if metastases are ruled out, the treatment is determined to a certain extent by the duration, site, and extent of the lesion. If the treatment is non-operative, Coley's toxins, radium, and X-ray should be administered. If surgery is indicated, the growth may be destroyed locally by cautery, by excision, by excision and cau-

TABLE X.—BONE OF ORIGIN AND SITE OF METASTASIS IN TWENTY-FIVE CASES OF OSTEOGENIC SARCOMA

| Bone of origin                                  | No. cases | Lung | Right pleura | Inguinal lymph nodes | Axillary lymph nodes | Abdominal lymph nodes | Pelvis | Rib | Jaw | Ilium | Acetabulum | Right femur | Sacrum | Right humerus | Skull | Vertebrae | Mediastinum | Abdominal cavity | Spleen | Liver | Skin | Bladder | Kidney | Sacro-iliac joint | Total |    |
|---|-----------|------|--------------|----------------------|----------------------|-----------------------|--------|-----|-----|-------|------------|-------------|--------|---------------|-------|-----------|-------------|------------------|--------|-------|------|---------|--------|-------------------|-------|----|
| Osteogenic sarcoma                              |           |      |              |                      |                      |                       |        |     |     |       |            |             |        |               |       |           |             |                  |        |       |      |         |        |                   |       |    |
| Spindle cell                                    |           |      |              |                      |                      |                       |        |     |     |       |            |             |        |               |       |           |             |                  |        |       |      |         |        |                   |       |    |
| Left femur                                      | 2         | 1    |              |                      | 1                    |                       | 1      | 1   |     |       |            |             |        |               |       |           | 1           |                  |        |       |      |         |        |                   | 5     |    |
| Right tibia                                     | 1         |      |              |                      |                      |                       |        |     |     | 1     |            |             |        |               |       |           |             |                  |        |       |      |         |        |                   | 1     |    |
| Right humerus                                   | 1         | 1    |              |                      |                      |                       |        |     |     |       |            |             |        |               |       |           |             |                  |        |       |      |         |        |                   | 1     |    |
| Left humerus                                    | 1         | 1    |              |                      |                      |                       |        |     |     |       |            |             |        |               |       |           |             |                  |        |       |      |         |        |                   | 1     |    |
| Right fibula                                    | 1         | 1    |              |                      |                      |                       |        |     |     |       |            |             |        |               |       |           |             | 1                |        |       |      |         |        |                   | 2     |    |
| Mixed cell                                      |           |      |              |                      |                      |                       |        |     |     |       |            |             |        |               |       |           |             |                  |        |       |      |         |        |                   |       |    |
| Left femur                                      | 3         |      | 1            | 2                    |                      | 1                     |        |     |     |       |            |             |        |               |       |           |             |                  |        | 1     |      |         |        |                   | 5     |    |
| Right tibia                                     | 1         | 1    |              |                      |                      |                       |        |     |     |       |            |             |        |               |       |           |             |                  |        |       |      |         |        |                   | 1     |    |
| Left tibia                                      | 1         | 1    |              | 1                    |                      |                       |        |     |     |       |            |             |        |               |       |           |             |                  |        |       |      |         |        |                   | 2     |    |
| Right tibia and os calcis                       | 1         | 1    |              |                      |                      |                       |        |     |     |       |            |             |        |               |       |           |             |                  | 1      | 1     | 1    |         |        |                   | 4     |    |
| Giant cell                                      |           |      |              |                      |                      |                       |        |     |     |       |            |             |        |               |       |           |             |                  |        |       |      |         |        |                   |       |    |
| Right femur                                     | 1         | 1    |              |                      |                      |                       |        |     |     |       |            |             |        |               |       |           |             |                  |        |       |      |         | 1      |                   | 2     |    |
| Cell unclassified                               |           |      |              |                      |                      |                       |        |     |     |       |            |             |        |               |       |           |             |                  |        |       |      |         |        |                   |       |    |
| Right femur                                     | 1         | 1    |              |                      |                      |                       |        |     |     |       |            |             |        |               |       |           |             |                  |        | 1     |      |         |        |                   | 2     |    |
| Left femur                                      | 2         | 2    |              |                      |                      |                       |        |     |     |       |            |             |        |               |       |           |             |                  |        |       |      |         |        |                   | 2     |    |
| Right tibia                                     | 3         | 2    |              |                      |                      |                       |        |     |     | 1     |            |             |        |               |       |           |             |                  |        |       |      | 1       |        |                   | 4     |    |
| Left tibia                                      | 2         | 1    |              | 1                    |                      |                       |        |     |     | 1     | 1          |             |        |               |       |           |             |                  |        |       |      |         |        | 1                 | 5     |    |
| Right ilium                                     | 1         |      |              |                      |                      |                       |        |     |     |       |            |             |        | 1             | 1     | 1         |             |                  |        |       |      |         |        |                   | 3     |    |
| First metatarsal, right                         | 1         | 1    |              | 1                    |                      |                       |        |     |     |       |            |             |        |               |       |           | 1           |                  |        | 1     |      |         |        |                   | 4     |    |
| First cuneiform, right,<br>and first metatarsal | 1         | 1    |              |                      |                      |                       |        |     |     |       |            | 1           | 1      |               |       |           |             |                  |        |       |      |         |        |                   | 3     |    |
| Third rib, left                                 | 1         |      |              |                      |                      |                       |        |     |     |       |            |             |        |               |       | 1         |             |                  |        |       |      |         |        |                   | 1     |    |
| Total cases                                     | 25        |      |              |                      |                      |                       |        |     |     |       |            |             |        |               |       |           |             |                  |        |       |      |         |        |                   |       |    |
| Total metastases :                              |           | 16   | 1            | 5                    | 1                    | 1                     | 1      | 1   | 1   | 2     | 1          | 1           | 1      | 1             | 1     | 2         | 2           | 1                | 1      | 4     | 1    | 1       | 1      | 1                 | 1     | 48 |

tery, or by amputation, followed by non-operative measures such as irradiation and Coley's toxins. In the experience of Meyerding, amputation and closure without drainage constitute the most certain means of disposing of the tumor. Local application of radium or X-ray over the chest, and Coley's toxins are advised following operation.

Bloodgood (8) refers to five cases of bone sarcoma treated by irradiation with good results. He treats giant-cell tumors generally by means of curettement and cauterization. Sarcomas of bone are treated by resection or amputation. In 1921 the

percentage of 5-year cures following amputation or resection for osteogenic sarcoma was 4 per cent, and in 1929 it was 35 per cent (9). In the experience of Bloodgood, the 5-year cures by amputation did not include any cases of the upper extremity or scapula, and of the lower extremity only up to the middle third of the femur. There are no records of cures of sarcoma of the upper third of the femur by either amputation or irradiation.

A study of Table XI reveals the type of surgical or non-surgical treatments administered in the 45 cases in the group; the average period of time elapsing from the date

of the first symptoms to the date of the first treatment; also the average period of time up to November 1, 1930, the living patients underwent treatment, and to the date of death of those patients who died.

It is noted that in the case of thirty-eight patients with osteogenic sarcoma, amputation was the treatment in twenty-eight instances, and of this number five, or 17.8 per cent, are alive. In the case of five patients with benign giant-cell tumor whose treatment consisted of amputation, all were alive as of November 1, 1930.

Disarticulation was used as a surgical measure in three cases of osteogenic sarcoma, and of these but one was alive as of November 1, 1930. Disarticulation was resorted to in the case of the patient with unclassified sarcoma, with a fatal outcome. It was the surgical procedure in the case of a patient with a benign giant-cell tumor and also in a case with a benign osteogenic tumor, in which instances the outcome was favorable.

Resection of the bone was resorted to in two cases of osteogenic sarcoma with fatal results. It was the treatment used in a case of benign osteogenic tumor with a favorable outcome.

Excision of the tumor was the treatment used in two cases of osteogenic sarcoma, one of which is alive. It was also used in the treatment of a case of benign giant-cell tumor, with a favorable outcome.

Curettement was used as a surgical measure in four cases of osteogenic sarcoma, of which number but one is alive. It was also used in two cases of benign giant-cell tumor, both of which are still alive.

There were but two patients with osteogenic sarcoma who received either X-ray or radium treatment alone, both of whom died.

There were sixteen patients with osteogenic sarcoma who received either X-ray or radium treatment or both, in addition to undergoing some surgical operation, and of

this number but two are alive. One case of benign giant-cell tumor and one case of benign osteogenic tumor received radium or X-ray therapy or both, in addition to undergoing some surgical operation. Both of these cases are alive.

Three patients with osteogenic sarcoma received treatment with Coley's toxins. Two of these underwent a surgical operation in addition, with favorable results. One of the patients with osteogenic sarcoma, whose treatment consisted only of Coley's toxins, died.

Of the group of thirteen living cases, it is noted that the average time between the appearance of symptoms and first treatment was 15.5 months. In the case of the thirty-two patients who died, the average time was 12.8 months. This means that the fatal cases were more rapid in their course, *i.e.*, the diagnosis was made sooner and the treatment administered earlier than in the patients who lived.

The average period of time of the thirteen living cases from the date of the first treatment to November 1, 1930, the date of this study, was 122.6 months. In the case of the thirty-two patients who died, the average period of time from the date of first treatment to the date of death was 21.4 months, the range being from 4 to 86 months.

Of the group of thirteen living cases, the average period from the date of first symptoms to November 1, 1930 ( $15.5 + 122.6$  months), was 138.1 months. The range was from a minimum time of 121 months to a maximum time of 161 months. Among the thirty-two patients who died, the average period of time from the date of first symptoms to date of death ( $12.8 + 21.4$  months) was 34.2 months. The range was from a minimum time of 3 months to a maximum time of 113 months.

#### RESULTS OF TREATMENT

A study of Table XII indicates the re-

TABLE XI.—TYPE OF TREATMENT ADMINISTERED, AVERAGE PERIOD OF TIME FROM DATE OF FIRST SYMPTOMS TO FIRST TREATMENT, ALSO AVERAGE PERIOD OF TIME PATIENT UNDERWENT TREATMENT TO NOVEMBER 1, 1930 (LIVING CASES), OR TO DATE OF DEATH

| Type of treatment                                 | No. cases studied | Average period of time from first symptoms to first treatment |                              |           |                              | Average period of time patient underwent treatment to Nov. 1, 1930 (living cases), or to date of death |                              |           |                              |
|---|-------------------|---|------------------------------|-----------|------------------------------|--|------------------------------|-----------|------------------------------|
|   |                   | Living  |                              | Dead      |                              | Living   |                              | Dead      |                              |
|   |                   | No. cases   | Average period of time (mo.) | No. cases | Average period of time (mo.) | No. cases  | Average period of time (mo.) | No. cases | Average period of time (mo.) |
| Osteogenic sarcoma                                |                   |   |                              |           |                              |  |                              |           |                              |
| Amputation  | 14                | 3   | 21.0                         | 11        | 8.2                          | 3  | 111.7                        | 11        | 18.4                         |
| Excision and amputation                           | 1                 |   |                              | 1         | 6.0                          |  |                              | 1         | 12.0                         |
| Resection   | 1                 |   |                              | 1         | Unrec.                       |  |                              | 1         | 22.0                         |
| Disarticulation                                   | 1                 | 1   | 13 da.                       |           |                              | 1  | 142.0                        |           |                              |
| X-ray and amputation                              | 3                 |   |                              | 3         | 33.3                         |  |                              | 3         | 16.7                         |
| Curettement, amputation, and X-ray                | 1                 |   |                              | 1         | 1.0                          |  |                              | 1         | 25.0                         |
| X-ray and resection                               | 1                 |   |                              | 1         | 12.0                         |  |                              | 1         | 4.0                          |
| Amputation, disarticulation, and X-ray            | 1                 |   |                              | 1         | 18.0                         |  |                              | 1         | 55.0                         |
| Radium and amputation                             | 2                 |   |                              | 2         | 10.5                         |  |                              | 2         | 14.0                         |
| Radium and disarticulation                        | 1                 |   |                              | 1         | 8.0                          |  |                              | 1         | 38.0                         |
| Excision, curettement, radium, and Coley's toxins | 1                 | 1   | 5.0                          |           |                              | 1  | 127.0                        |           |                              |
| X-ray, radium, and amputation                     | 3                 | 1   | 27.0                         | 2         | 5.5                          | 1  | 108.0                        | 2         | 17.0                         |
| X-ray, radium, curettement, and amputation        | 2                 |   |                              | 2         | 17.0                         |  |                              | 2         | 9.0                          |
| X-ray, radium, amputation, and Coley's toxins     | 1                 | 1   | 81.0                         |           |                              | 1  | 80.0                         |           |                              |
| X-ray   | 1                 |   |                              | 1         | Unrec.                       |  |                              | 1         | Unrec.                       |
| X-ray and radium                                  | 1                 |   |                              | 1         | Unrec.                       |  |                              | 1         | Unrec.                       |
| Coley's toxins                                    | 1                 |   |                              | 1         | Unrec.                       |  |                              | 1         | Unrec.                       |
| Unrecorded  | 2                 |   |                              | 2         |                              |  |                              | 2         |                              |
| Unclassified sarcoma (extra-periosteal)           |                   |   |                              |           |                              |  |                              |           |                              |
| Disarticulation                                   | 1                 |   |                              | 1         | 27.0                         |  |                              | 1         | 86.0                         |
| Benign giant-cell tumor                           |                   |   |                              |           |                              |  |                              |           |                              |
| Amputation  | 2                 | 2   | 2.5                          |           |                              | 2  | 133.5                        |           |                              |
| Curettement and amputation                        | 1                 | 1   | 1.0                          |           |                              | 1  | 145.0                        |           |                              |
| Excision, amputation, and disarticulation         | 1                 | 1   | 6.0                          |           |                              | 1  | 126.0                        |           |                              |
| Curettement, amputation, and X-ray                | 1                 | 1   | 15.0                         |           |                              | 1  | 118.0                        |           |                              |
| Benign osteogenic tumor                           |                   |   |                              |           |                              |  |                              |           |                              |
| X-ray, radium, resection, and disarticulation     | 1                 | 1   | 3 da.                        |           |                              | 1  | 146.0                        |           |                              |
| Total   | 45                | 13  | 15.5                         | 32        | 12.8                         | 13   | 122.6                        | 32        | 21.4                         |

sults of treatment of the 45 cases of bone tumor by type of tumor. It is noted that of the thirty-eight cases of osteogenic sarcoma seven, or 18.4 per cent, are alive,

and thirty-one, or 81.6 per cent, are dead; one case of unclassified sarcoma is dead; five cases of giant-cell sarcoma are alive; one case of benign osteogenic sarcoma is

TABLE XII.—PRESENT STATUS OF FORTY-FIVE CASES OF BONE TUMOR

| Type of bone tumor                      | No. living (as of November 1, 1930) | No. dead | Total |
|---|-------------------------------------|----------|-------|
| Osteogenic sarcoma:                     |                                     |          |       |
| Spindle cell                            | 2                                   | 7        | 9     |
| Mixed cell                              | 1                                   | 7        | 8     |
| Giant cell                              | 0                                   | 1        | 1     |
| Cell unclassified                       | 4                                   | 16       | 20    |
| Total (osteogenic sarcoma)              | 7                                   | 31       | 38    |
| Percentage                              | 18.4                                | 81.6     | 100.0 |
| Unclassified sarcoma (extra-periosteal) | 0                                   | 1        | 1     |
| Benign giant-cell tumor                 | 5                                   | 0        | 5     |
| Benign osteogenic tumor                 | 1                                   | 0        | 1     |
| Total (other than osteogenic sarcoma)   | 6                                   | 1        | 7     |
| Percentage                              | 85.7                                | 14.3     | 100.0 |
| Grand total                             | 13                                  | 32       | 45    |
| Percentage                              | 28.9                                | 71.1     | 100.0 |

TABLE XIII.—AFTER-HISTORY OF THIRTEEN LIVING CASES OF BONE TUMOR

| Type of bone tumor      | Length of time patient has survived bone tumor |          |          |          | Total |
|-------------------------|--|----------|----------|----------|-------|
|                         | 10 years                                       | 11 years | 12 years | 13 years |       |
| Osteogenic sarcoma:     |  |          |          |          |       |
| Spindle cell            |  | 1        |          | 1        | 2     |
| Mixed cell              |  | 1        |          |          | 1     |
| Cell unclassified       | 1  | 3        |          |          | 4     |
| Benign giant-cell tumor | 2  | 2        | 1        |          | 5     |
| Benign osteogenic tumor |  |          | 1        |          | 1     |
| Total                   | 3  | 7        | 2        | 1        | 13    |

alive. Accordingly, of the group of bone tumors other than osteogenic sarcoma, seven cases in all, six, or 85.7 per cent, are alive, and one, or 14.3 per cent, is dead.

Considering the whole group of 45 cases of bone tumor, thirteen, or 28.9 per cent, are alive, and thirty-two, or 71.1 per cent, are dead.

#### PERIOD OF INVOLVEMENT

Table XIII indicates the length of time the thirteen living cases have survived bone tumor. Of the seven cases of osteogenic sarcoma, one has survived the disease ten years, five have had the disease for eleven years, and one for thirteen years.

Of the five cases of benign giant-cell tumor, two have survived the disease for ten years, two for eleven years, and one for twelve years.

One case of benign osteogenic tumor has survived the disease for twelve years.

There were thirty-two patients with bone tumor who died. Thirty-one were cases of osteogenic sarcoma and one was a case of unclassified sarcoma. Table XIV shows that of the thirty-one cases of osteogenic sarcoma, the duration of the disease was from less than one year in three instances to a period of from six to seven years in four instances. In twelve cases, which was

TABLE XIV.—AFTER-HISTORY OF THIRTY-TWO CASES OF BONE TUMOR WHO DIED

| Type of bone tumor                      | Period of involvement before death |           |           |           |           |           |           |         | Total |
|---|------------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|---------|-------|
|   | Less than 1 year                   | 1-2 years | 2-3 years | 3-4 years | 4-5 years | 5-6 years | 6-7 years | 9 years |       |
| Osteogenic sarcoma:                     |                                    |           |           |           |           |           |           |         |       |
| Spindle cell                            | 1                                  | 1         | 3         | 1         |           |           | 1         |         | 7     |
| Mixed cell                              |                                    | 2         | 1         | 1         | 1         |           | 2         |         | 7     |
| Giant cell                              |                                    |           | 1         |           |           |           |           |         | 1     |
| Cell unclassified                       | 2                                  | 4         | 7         | 1         |           | 1         | 1         |         | 16    |
| Total osteogenic sarcoma                | 3                                  | 7         | 12        | 3         | 1         | 1         | 4         |         | 31    |
| Unclassified sarcoma (extra-periosteal) |                                    |           |           |           |           |           |           | 1       | 1     |
| Grand total                             | 3                                  | 7         | 12        | 3         | 1         | 1         | 4         | 1       | 32    |

the largest number, the duration of the disease was from two to three years.

There was one case of unclassified sarcoma in which the duration of the disease was nine years.

#### EFFECT OF TRAUMA UPON FINAL OUTCOME OF CASES OF BONE TUMOR

A study was made to ascertain if there was a relationship of trauma to the final outcome of cases of bone tumor. It was found that of the thirteen cases with a positive history of trauma four, or 30.8 per cent, died; and of the thirty-two cases with no history of trauma nine, or 28.1 per cent, died. It is thus seen that trauma does not influence the final outcome of cases of bone tumor.

#### CAUSES OF DEATH

In reviewing the clinical records of the thirty-two cases of bone tumor who died, for the specific cause of death, it was found that in nearly all instances metastases resulting from the original tumor or the original tumor itself was the cause of death. In a few cases the death was due to a contributory condition not related to the neoplasm, such as acute myocarditis, hydropneumothorax, or chronic nephritis.

#### SUMMARY AND CONCLUSIONS

1. The present study is an analysis of 45 cases of bone tumor among ex-service men. Of the group studied, thirty-eight, or 84.5 per cent, were osteogenic sarcoma; five, or 11.1 per cent, were cases of benign giant-cell tumor; one was a case of unclassified sarcoma, and one was a case of benign osteogenic tumor.

2. According to the histologic structure of the predominant cell of the tumors, ten of the cases were of the spindle-cell type; eight were of the mixed-cell type; six were giant-cell tumors (five benign and one osteogenic sarcoma); one case showed the characteristic bone and cartilage cells of a benign osteogenic tumor, and in twenty instances the predominant type of cell was not recorded, the microscopic diagnosis having been recorded as sarcoma.

3. Thirteen of the 45 cases of bone tumor gave a history of trauma prior to the inception of the disease. The length of time between the injury and the first symptoms or signs of a tumor varied from less than one month to forty months. In the majority of cases the bone tumor was noted within one year after the patient sustained the injury.

4. The average age of the 45 patients at the time of the diagnosis of bone tumor was

24.7 years—the youngest patient was 19 years and the oldest 32 years of age.

Of the thirteen patients who were alive at the time of this study (November 1, 1930), the youngest was 31 years of age, the oldest was 42 years of age, and the average of the living patients was 37 years.

Of the thirty-two patients who had died, the youngest was 22 years of age, the oldest was 34 years, and the average age at death was 27.4 years.

5. In studying the distribution of bone tumors in the group of 45 cases it was found that the femur was affected in 46.7 per cent, the tibia in 24.5 per cent, and the humerus in 4.4 per cent.

Of the five cases of benign giant-cell tumor, three were in the right femur, one in the left tibia, and one was in the left humerus and left scapula.

The most frequent sites of the bone tumors were the lower end of the femur and the upper end of the tibia. The fact that the portions of the bones at or near the knee are most frequently affected with bone tumor, and because this part of the body is frequently subjected to injury, has led many observers to maintain that trauma is a definite factor in the causation of bone tumor.

6. Osteogenic sarcomas are characterized by the ability to extend to or to invade normal tissues, as well as to recur after excision. In the group of 45 cases, eleven, or 24.4 per cent, gave evidence of an extension or a recurrence. Of the eleven cases, a recurrence was noted in the stump in five instances, and extensions to bones or tissues adjacent to the site of origin of the sarcoma in six instances.

7. Metastases were present in twenty-five, or 55.6 per cent, of the group of 45 cases. The highest incidence of metastases, 75 per cent, was noted among the eight cases of mixed-cell type of osteogenic sarcoma. It was found that there was an average of 1.8 metastatic foci in each case.

The most frequent sites were the lungs and the inguinal, axillary, and abdominal lymph nodes. It was also noted that metastases occurred in bones in twelve instances.

8. In reviewing the diagnostic symptoms and signs of bone tumor as recorded in the histories, it was noted that those most frequently mentioned were pain and swelling, either singly or in combination, and partial or total loss of function. In nineteen instances the roentgenogram was suggestive of bone tumor. In twenty-six instances there was no record of a roentgenologic examination.

9. Of the group of thirty-eight patients with osteogenic sarcoma, amputation was the surgical procedure in twenty-eight instances, and of this number five, or 17.8 per cent, are alive. Amputation was done in all of the five cases of benign giant-cell tumor—all of the five patients are still living. Disarticulation was the surgical procedure in six cases, and of this number three are still alive. Resection of the bone was done in three instances—one of the patients is still alive. Excision of the tumor was done in three instances—two of the patients are still living. Curettement was done in six instances—three of the patients are living and three are dead.

Two patients with osteogenic sarcoma received either X-ray or radium treatment alone—both of these patients are dead.

Sixteen patients with osteogenic sarcoma received either X-ray or radium treatment, or both, in addition to undergoing a surgical operation, and of this number but two are alive. One case of benign giant-cell tumor and one case of benign osteogenic tumor received radium or X-ray therapy, or both, in addition to undergoing some surgical operation—both of these patients are alive.

Of three patients receiving treatment with Coley's toxins, two are alive and one is dead. The two cases still living also re-



ceived surgical treatment. The patient who died received Coley's toxins only.

10. The average duration of the bone tumor in the thirteen living cases has been 138.1 months, the range being from a minimum of 121 months to a maximum of 161 months.

The average duration of the bone tumor in the thirty-two patients who died was 34.2 months, the range being from a minimum of 3 months to a maximum of 113 months.

11. Of the thirty-eight cases of osteogenic sarcoma, seven, or 18.4 per cent, are alive, and 31, or 81.6 per cent, are dead. Of the group of bone tumors other than osteogenic sarcoma, seven cases in all, six, or 85.7 per cent, are alive, and one, or 14.3 per cent, is dead. Considering the group of 45 cases as a whole, thirteen, or 28.9 per cent, are alive, and 32, or 71.1 per cent are dead.

12. The thirteen living cases have survived bone tumor for the following periods: three have lived for ten years; seven have survived the condition eleven years; two have lived for twelve years, and one has lived thirteen years after the inception of bone disease.

13. The duration of bone tumor in the thirty-two cases who died was as follows: three lived less than one year; seven from one to two years; twelve from two to three

years; three from three to four years; one from four to five years; one from five to six years; four from six to seven years, and one patient with unclassified sarcoma lived for nine years.

14. In nearly all instances the cause of death was either the original tumor or metastases arising from it. In several instances there was a record of a contributory cause of death from such conditions as acute myocarditis, hydropneumothorax, or chronic nephritis.

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## OSTEITIS FIBROSA LOCALISATA

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"OSTEITIS FIBROSA" is the term applied to the pathologic process observed in a group of bone diseases which appear at dissimilar age periods and present extremely variable clinical and roentgenologic manifestations.<sup>1</sup> Presenting itself in youth as a strictly localized bone cyst—benign and tending to heal after curetting—it is common enough and its clinical course well known. Paget's disease, occurring later in life, involving much of the skeleton, presenting little or no tendency to recovery, yet having a microscopic appearance similar to, if not identical with, that of a bone cyst, is also a well recognized phenomenon.

An apparently identical process limited to one bone, but involving that bone throughout its entire extent, is less commonly observed; however, some fifty cases had been collected from the literature in 1928<sup>2</sup> and, without doubt, many more cases have been seen but not reported.

We have had an opportunity to observe a lesion which we believe to be still less common, a process resembling that of Paget's disease, both roentgenologically and microscopically, but yet limited not only to one bone but to one area of one bone (Case 1, Figs. 1, 2, 3, 8). A biopsy was performed, establishing the pathologic nature of the lesion. It has been possible to follow the course of the disease over a period of more than two and one-half years. During that time successive X-ray examinations have shown a gradual extension along the shaft of the bone at the rate of a little less

than 1 cm. a year. No bowing deformity has yet been observed and no other bones are involved, but the suggestion is certainly very strong that this case represents an early stage of a condition which will later manifest itself as Paget's disease of the entire femur, if not of other bones as well.

Case 2 represents the not uncommon form of osteitis fibrosa, occurring as a well localized lesion in a young individual, and giving rise to a roentgen appearance suggesting multilocular bone cavities. It is included in this report for comparison with Case 1, inasmuch as the microscopic sections were also made and the case was followed by roentgen examinations over a period of nearly two years.

Case 1.—The patient, a railroad conductor, aged 46, was first seen in November, 1927, with hydrops of the right knee, following a minor twist which he received in alighting from a moving train one month previously. No deformity was noted clinically (except that due to synovial effusion). He had been unaware that his knee was not normal before the minor injury mentioned. X-rays films taken at this time (Fig. 1) show, at the lower end of the femur, involving the shaft and extending down to the articular surface, a well circumscribed area of irregular rarefaction, with many coarse trabeculae tending, in general, to be parallel with the shaft, and a slight lateral expansion of the cortex, but no destruction.

A clinical diagnosis of osteitis fibrosa was made but the possibility of some other lesion (*e.g.*, chondroma or even less benign neoplasm) was considered, and a biopsy was performed. A cortex of not abnormal appearance was encountered, beneath which was a finely lamellar structure, presenting moderate bleeding and absence of fat. The

<sup>1</sup>An extensive discussion of the pathology of osteitis fibrosa and of its possible relation to giant-cell tumor will be found in an article by Geschickter, C. F., Copeland, M. M., and Bloodgood, J. C.: *Arch. Surg.*, August, 1929, XIX, 169. A brief discussion of the classification of the various clinical manifestations and roentgen variations has been published by one of us (L. H. G.), *Am. Jour. Roentgenol. and Rad. Ther.*, December, 1929, XXII, 517.

<sup>2</sup>Goldstein, H. I., and Goldstein, H. Z.: *Mono-osteitic Paget's disease of bones. Internat. Clin.*, September, 1928, III, 210.



Fig 1 (top) Case 1, Nov 21, 1927 Roentgenogram showing an extensive area of irregular rarefaction involving the lower fourth of the right femur, the lesion involves the shaft and distal end of the femur down to the articular surface. Many coarse trabeculae are scattered throughout the rarefied area. These tend, in general, to lie parallel to the bone shaft. There is a slight expansion of the cortex, without destruction. Films of the remainder of the skeleton are negative. *Roentgen Diagnosis*—Osteitis fibrosa localisata, hyperostotic type. *Clinical Diagnosis*—Benign lesion, osteitis fibrosa (?). *Pathologic Diagnosis*—Osteitis fibrosa.

Fig 2 (middle) Case 1, Jan 19 1929 Roentgenogram

microscopic appearance is shown in Figure 8, in which the bone spicules are surrounded by dense layers of osteoblasts, the area between the spicules being occupied by the characteristic loose fibrous tissue of osteitis fibrosa. Healing of the biopsy wound was prompt, and after three weeks' rest in bed, the hydrops of the knee had completely subsided. The patient was allowed to return at first to light work and later to his regular occupation as a freight-train conductor, and has remained free from symptoms to date (three years).

X-ray films taken fourteen months after the biopsy (Fig. 2) show an extension of the process about 1 cm. farther up the shaft, and films taken two years and nine months from the date of the first observation, show an extension of about 2 cm., the extension being at the rate of a little less than 1 cm. a year. All of the films were taken with the same technic, on the same apparatus, and were checked by measurements between fixed points on the bone in each, so that we believe the estimation of the extension as stated is accurate.

Case 2.—The patient,<sup>3</sup> a housewife, aged 24, first noticed a swelling and soreness at the middle of the left shin, five months before admission to the hospital. There had been no pain independent of pressure over the lesion and no signs of acute inflammation; no history of injury was obtained. Her past history contained nothing of special interest and her family history was not remarkable, except that one brother died at the age of 12 of tuberculosis of the spine.

<sup>3</sup>Patient of Dr. Stanley Mertzner, to whom we are indebted for permission to report.

#### Captions continued

gram showing the condition fourteen months later. The lesion is a little more extensive, its limit being about 1 cm. farther up the shaft. Otherwise there is no change.

Fig. 3 (bottom) Case 1, Aug 11, 1930 Roentgenogram showing the condition nineteen months later (2 years and 9 months after Figure 1). There is a little more trabecular thickening along the cortex but no other change is noted, except that the upper limit is now about 2 cm. farther up the shaft than at the time of the first examination.



Fig 4 (top) Case 2, July 9, 1928. Roentgenogram showing an irregular "cystic" area of rarefaction, involving the shaft of the left tibia at the junction of the middle and lower thirds. There is a moderate expansion of the shaft anteriorly and laterally but no destruction of the cortex. The bony trabeculae, proximal to the main portion of the lesion, are coarser than normal. *Roentgen Diagnosis:* Osteitis fibrosa localisata, probably porotic type. *Clinical Diagnosis:* Benign lesion—bone cyst. *Pathologic Diagnosis:* Osteitis fibrosa.

Fig 5 (middle). Case 2, May 24, 1929. Films



Fig. 7. Case 2, Dec. 15, 1930. Roentgenogram showing condition thirteen months later. There is a further filling in of the operative defect, with restoration of the normal contour of the tibia. No further extension of the lesion. Note the absence of expansion anteriorly, seen in the first film.

The general physical examination disclosed nothing of note, except large chronically infected tonsils. At about the mid-point of the anterior surface of the left tibia there was a large, hard protuberance,  $3 \times 4$  cm. in extent, the surface smooth and the outline shading off gradually to the normal bone surface. The Wassermann reaction was negative.

The X-ray films taken at this time are shown in Figure 4. The lamellae of increased density, paralleling the shaft of the bone (cf. Case 1), are also evident here, but to a less degree, and, in addition, there is seen the usual appearance presented by osteitis fibrosa in youth—the formation of cavity-like areas (cysts) in the bone.

#### Captions continued

taken approximately eight months after the operation. There is a post-operative defect along the anterior third of the bone; the tibia is apparently about 5 mm. wider than in the first film. There is a linear area of rarefaction across the middle of the lesion—umbauende zone (?).

Fig. 6 (bottom). Case 2, Nov. 6, 1929. Roentgenogram showing the condition six months later. There is a filling in of the operative defect anteriorly, and possibly a slight diminution of the width of the tibia at the level of the center of the lesion. Note the apparent recalcification of the most laterally placed rarefied area.



Fig. 1 (top). Case 1, Nov. 21, 1927. Roentgenogram showing an extensive area of irregular rarefaction involving the lower fourth of the right femur; the lesion involves the shaft and distal end of the femur down to the articular surface. Many coarse trabeculae are scattered throughout the rarefied area. These tend, in general, to lie parallel to the bone shaft. There is a slight expansion of the cortex, without destruction. Films of the remainder of the skeleton are negative. *Roentgen Diagnosis:* Osteitis fibrosa localisata, hyperostotic type. *Clinical Diagnosis:* Benign lesion, osteitis fibrosa (?). *Pathologic Diagnosis:* Osteitis fibrosa.

Fig. 2 (middle) Case 1, Jan. 19, 1929. Roentgeno-

microscopic appearance is shown in Figure 8, in which the bone spicules are surrounded by dense layers of osteoblasts, the area between the spicules being occupied by the characteristic loose fibrous tissue of osteitis fibrosa. Healing of the biopsy wound was prompt, and after three weeks' rest in bed, the hydrops of the knee had completely subsided. The patient was allowed to return at first to light work and later to his regular occupation as a freight-train conductor, and has remained free from symptoms to date (three years).

X-ray films taken fourteen months after the biopsy (Fig. 2) show an extension of the process about 1 cm. farther up the shaft, and films taken two years and nine months from the date of the first observation, show an extension of about 2 cm., the extension being at the rate of a little less than 1 cm. a year. All of the films were taken with the same technic, on the same apparatus, and were checked by measurements between fixed points on the bone in each, so that we believe the estimation of the extension as stated is accurate.

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<sup>3</sup>Patient of Dr. Stanley Mentzer, to whom we are indebted for permission to report.

#### Captions continued

gram showing the condition fourteen months later. The lesion is a little more extensive, its limit being about 1 cm. farther up the shaft. Otherwise there is no change.

Fig. 3 (bottom). Case 1, Aug. 11, 1930. Roentgenogram showing the condition nineteen months later (2 years and 9 months after Figure 1). There is a little more trabecular thickening along the cortex but no other change is noted, except that the upper limit is now about 2 cm. farther up the shaft than at the time of the first examination.

## BONE CYSTS

By ALEXANDER R COLVIN, M.D., St. PAUL, MINNESOTA

IN the differential diagnosis of the pathologic conditions affecting organs or tissues, there is often one condition around which center most of the difficulties of the problem. In the mammary gland, cystic mastitis or fibro-epithelial degeneration, because of its clinical varieties and unknown possibilities, seems to occupy this position. In bone, osteitis fibrosa, occupying a mid-position between neoplasm and inflammation, causes, at times, a good deal of confusion. Because of the frequent presence of cyst formation in this disease, perhaps the subject of bone cyst formation has been associated more often in our minds with osteitis fibrosa than with any other one pathologic condition of bone. It is important, however, to remember when we are facing the problem of differential diagnosis the various conditions of bone in which cyst formation occurs.

- (1) As degeneration product of a solid tumor,
- (2) As a parasitic cyst,
- (3) As the end-product of an infectious osteomyelitis,
- (4) As the product of rarefying process in bone, *e.g.*, arthritis deformans, in osteoporosis, and in osteomalacia,
- (5) Rickets,
- (6) Callus cysts,
- (7) Osteitis fibrosa.

After a consideration of all of these causes of bone cyst, there remains the genuine simple bone cyst, which, perhaps, has nothing to do with any of the conditions named. This simple cyst is found most frequently in youth; is usually a single cavity, although at times divided by septa; has a smooth wall provided with a definite limiting membrane, and contains a yellowish, slimy, and occasionally a blood-tinged fluid. It is most frequently found in the



Fig. 1. Roentgenogram of a bone cyst in the upper end of the ulna in a girl 5 years of age, following an injury (Path No 9,025).

metaphyseal region of the shaft of the long bones. A cyst conforming to this description is always a benign lesion.

The following case, seen clinically over a period of twenty-five years, can fairly be classified as a genuine simple bone cyst. The patient, a girl of 5 years, gave a history of injury, with an immediate swelling which gradually increased in size. This history, however, could be interpreted in



Figs. 2-A and 2-B. Roentgenogram of the same lesion twenty-five years later. Figure 2-A shows the healed lesion and Figure 2-B shows the normal unaffected arm for comparison.

two ways, either as an etiologic factor, or—and this seemed more likely—an injury to an existing condition. She presented a swelling of the upper end of the ulna, which was neither painful nor tender. Pressure over this area resulted in a parchment crackling, characteristic of bodies with thin, more or less elastic walls, such as is felt most clearly on indenting a tennis ball. When this was first seen it presented an appearance as shown in Figure 1. For a time there was a steady increase in size and then a gradual decrease, extending over a period of years, until, at the present writing, there is a barely perceptible difference in the ulna of the two forearms. The radiograph, however, reveals that the bone at the site of the cyst is still very slightly larger than the opposite one (Figs. 2-A and 2-B), the trabecular markings somewhat coarser, and an area about the size of a small pea, which resembles a small cavity, is seen.

Tietze, after his review of our knowledge of bone cysts in *Ergebnisse der Chirurgie und Orthopädie*, in 1911, states that we can easier say all that a bone cyst is *not*, than we can say what its significance really is.

The observation of the outcome of this case confirms, as to its character, in a very positive manner, the opinions expressed years ago; for instance, Mikulicz said, in 1904, that it was always a benign process, basing this opinion upon the fact that it never metastasized and that after spontaneous fracture, which frequently occurs in bone cysts, callus formation and consolidation always take place. The writer can confirm this observation from several experiences. The disappearance of the cyst being reported, of course, confirms in positive manner of Mikulicz's opinion.

The somewhat rapid evolution of the process in this case would, of course, seem to exclude all of the causes given for the formation of cysts in bone. It is, for in-

stance, unlikely that any tumor which has attained a certain size at the age of five, would grow and degenerate and begin to heal and disappear within a few years as this one did. For the same reason, osteitis fibrosa could not have anything to do with this genuine simple cyst.

In osteitis fibrosa the cysts, when present, are not the dominating features of the disease, but are, as it were, a by-product of the disease. The description of the clinical pathology of osteitis reads and looks more like a combination of inflammation and tumor formation than it does a primary cystic disease.

Inasmuch as the only study of the case which is the subject of this report was clinical and radiographic, nothing can really be added to our knowledge of the subject, except that a simple bone cyst in a child can in time spontaneously disappear and remain cured over a period of twenty-five years. Surgery was refused in this case by the parents, and, in consequence, the observations referred to were possible. Inasmuch as the case was almost symptomless, the enlargement in the contour of the bone was the first thing to be noticed; the physical signs were also characteristic—i.e., the egg-shaped enlargement and the crackling indentability. When the case first came under consideration the differential diagnosis from the various lesions enumerated in which cystic formation is only a part of the clinical pathology, seemed a matter of course.

The only other condition which I have seen in which the physical signs were the same, was cyst formation in the upper and lower jaw, one a follicular cyst and the other an adamantinoma, with cyst formation. The latter case well illustrates the necessity of studying the surrounding tissues in the operative exploration or treatment of bone cysts, for the recurrence of the cyst after operation in the adamantinoma case led finally to the finding of the

tumor tissue in the case of the cyst formation.

It is, of course, questionable whether or not the course pursued in this cyst of the ulna is often justifiable for the reason that radiographic study, while often convincing, is not always so. It must be emphasized that in the radiographic study it is necessary to view the radiograph with the mind actually considering the possible surgical pathology in each case, and even when this is done, it is perhaps easier to say from the radiograph that we are *not* dealing with a simple bone cyst than to say that we *are* dealing with one. The radiograph at least will enable us to reduce the number of possibilities, and the typical shape, the thinned-out cortical bone, and the absence of periosteal thickening will enable us to express an opinion of great probability. The form is not always regular in enchondroma and sarcoma, the latter perforating the bone comparatively early, but in giant-cell tumors it may never perforate.

In bone abscess, the encapsulating bone is dense and thickened; this is also true of bone gumma. The isolated masses of osteitis fibrosa are not always to be differentiated, and surgical exploration is usually necessary to establish a diagnosis. On exploration, the thin walls of the cyst, with the clear lining membrane and the comparatively clear fluid, will be quite evident. If one will keep in mind the number and variety of conditions in which bone cysts, in the broad sense, are found, and on exploration will note the character of the surrounding tissue, and, lastly, the microscopic character of the tissue, a diagnosis of the condition causing the cyst can usually be made.

For a wide and enlightening study of these various conditions, the work of Joseph C. Bloodgood, as given in his article on "Benign Bone Cysts, Osteitis Fibrosa, Giant-cell Sarcoma, and Bone Aneurysm of the Long Pipe Bones," in *Annals of Sur-*



gery, August, 1910, LII, 145, and the review of Alexander Tietze in *Ergebnisse der*

*Chirurgie und Orthopädie*, 1911, II, 32, are worth while reading.

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The Requirements of the Clinician from the Radiologist and *Vice Versa*. G. B. Batten. British Jour. Radiol., June, 1930, III, No. 30, p. 259.

The author believes that the requirements, in general, of clinicians from radiologists should be the same as from all other specialists, and, conversely, the radiologist may ask of the clinician any information which may help to elucidate the problem necessary for a correct diagnosis. Naturally, such pertinent information might be quite different from that needed by the bacteriologist or any other medical consultant. Only rarely is a clinical consultation requested and all information withheld for the good of the patient, and, similarly, in the best interests of the patient, such cases sent for roentgenological consultation must be equally infrequent.

The author explains the situation of the radiological personnel of England, there being

the pure roentgen specialists in London and larger hospital towns, but also a large group in the suburbs and small towns of general practitioner radiologists. The relations between the latter group and the clinician group are distinctly more difficult, and the most ethical dealings with both patients and clinical colleagues are necessary in such instances. The tendency of many younger clinicians to refer cases immediately for roentgen study before utilizing the simple means of physical examination is deplored, and every case should have something of a provisional diagnosis made before the X-ray study is attempted. The roentgenologist should then, for his part, report his conclusions, together with all findings upon which such conclusions are based, in every case attempting to avoid the vague without being too dogmatic.

J. E. HABBE, M.D.

# THE TREATMENT OF ADVANCED CANCER OF THE BREAST

By WILLIAM F. MACFEE, M.D., NEW YORK

FOR the purposes of definition in this discussion, advanced cancer of the breast is to be thought of as cancer which, because of its local or general development, has reached such a state as to offer no reasonable hope of cure. Treatment of such cancer thus becomes a question of palliation. In undertaking palliative treatment, however, we should consider very earnestly the best means of obtaining that end. The ideal, of course, is to procure the greatest possible comfort and sense of well-being to the individual for the greatest possible length of time. There is always the urge to "do something," but unless that urge is translated into well considered action, we may be chagrined to find that the state produced is worse than that which we have attempted to relieve. The effort may not give relief commensurate with the discomfort incident to the measures carried out.

It is obvious that few rules can be formulated which are applicable to all or even most of the cases. In certain cases, pathologic grading, suggested by Broders (1), and applied to mammary cancer by Greenough (2), and clinical grading introduced by Lee and Stubenbord (3), may be useful. The individual case, however, is largely an individual problem which must be considered from many angles. The mental and emotional qualities of the patient, for example, should enter into the appraisal. External ulceration may be abhorrent to one patient while another may be concerned almost entirely with painful manifestations of the disease. In general, the plan of treatment must depend upon the actual physical state and upon the patient's reaction to that condition. Treatment will, further, be determined by the therapeutic agencies available and by the efficiency to be expected in their application.



Fig. 1. Case 1 (August 15, 1928). Appearance before operation, showing extensive ulceration, with destruction of the nipple.

*Erythema.*—Erythema of the skin, overlying the tumor and spreading beyond its borders, is a bad prognostic sign. It usually means that diffusion has occurred and that carcinomatous thrombi occupy the subcutaneous venules and lymph spaces. Remote metastases are very probable. If these are not in evidence, radical mastectomy, with wide excision of skin, offers a remote but the only chance of cure. If not done, ulceration is likely to occur before the patient succumbs to other manifestations of



Fig. 4. Case 2 (October 9, 1930). Roentgenogram showing extensive involvement of the lumbar spine and pelvis. The patient was walking and free from symptoms after two months of intensive X-ray therapy.

struction. In cases of pleural metastases, however, considerable relief may be obtained by radiation. It is often effective in controlling pain and in diminishing the tendency toward pleural effusion. When effusion actually exists, aspiration, repeated as often as necessary, affords great relief. Handley (7) has advocated the parasternal implantation of radium as a means of preventing mediastinal metastases, but the value of the procedure seems doubtful.

*Abdominal Metastases.*—Peritoneal invasion, with the production of ascites, is perhaps the most common abdominal manifestation of metastatic carcinoma of the breast. Involvement of the liver, according to McWhorter and Cloud (8), occurs more often than involvement of the lungs, the figures given being 34 and 22 per cent, respectively. When it does occur it is late in producing symptoms, and much depends upon the exact location of the nodules. Carcinomatous tumors of the ovary, appearing secondary to breast cancer, as a sort of Krukenberg tumor, have been rarely observed. They usually give little in the way of early symptoms and are most often discovered after abdominal metastases have become general. Against such we are practically helpless. Radiation is sometimes effective but frequently fails to retard the disease to an appreciable extent. If high dosage is attempted, nausea and prostration may cause discomfort out of proportion to the relief obtained.

Repeated tapping is very helpful in relieving the distress incident to the accumulation of ascitic fluid. The danger of perforating the intestines with the trocar is less than it would seem, even when there are palpable intra-abdominal carcinomatous masses.

*Bone Metastases.*—Except for direct extension to the ribs, Carnett and Howell (9) give the order of frequency of bone metastases in breast cancer as: homolateral shoulder girdle, third to sixth thoracic verte-

well for more than two years after operation for metastasis in the supraclavicular nodes. At the time of operation, it was possible only with the greatest difficulty to separate the nodes from the subclavian vein. X-ray treatment of supraclavicular metastases is not always satisfactory, because of scar formation involving the brachial plexus. In elderly patients, however, radiation is perhaps preferable to surgery.

*Thoracic Metastases.*—These are seen most often as post-operative recurrences, but may appear before the local breast tumor seems far advanced. When the mediastinal nodes become extensively involved, partial tracheal obstruction may supervene to harass the patient. Radiation in such cases is seldom beneficial for more than a few months and is attended with some danger. Sufficient additional swelling may rarely be brought about to produce complete ob-

bra, upper lumbar vertebrae, the pelvic bones, and the lower cervical vertebrae. This order is somewhat at variance with that given by Lenz and Freid (10), arrived at by a slightly different method of observation. The patient may be made helpless by bone destruction, pathologic fracture at any important site, or by pain. Destruction of the vertebral bodies, with resulting deformity and pressure on nerve roots, may cause incessant and excruciating pain. Involvement of the skull may be extreme without the production of notable symptoms.

In metastases to bone, radiotherapy frequently gives most gratifying results. Some cases show at least temporary arrest of the process, and certain others show definite regression of the disease. Another group of cases experiences partial or complete relief from pain, even though repeated roentgenographs show no improvement as to the progress of the disease (see Case 2, Figs. 3, 4, and 5). Pathologic fractures sometimes heal spontaneously (11) and sometimes with radiation, if not too heavily radiated.

*Metastases to the Central Nervous System.*—According to Lenz and Freid (10), this complication occurs in about one-fifth of the late cases. Sixty-eight of the cases diagnosed as spinal cord involvement had corresponding skull and vertebral metastases. This suggests that epidural metastatic growths, rather than actual implantations in the central nervous system, may be responsible for most of the central neurological symptoms. In some of the spinal cord cases, radiation is effective in the relief of pain, and occasionally it retards growth to some extent. Radiation of the skull, however, is generally unsatisfactory. It brings little relief and patients object to having the hair fall out.

#### ILLUSTRATIVE CASES

Case 1 (68,047).—A female, white, sixty-four years of age, was admitted to St. Luke's Hospital, August 14, 1928.

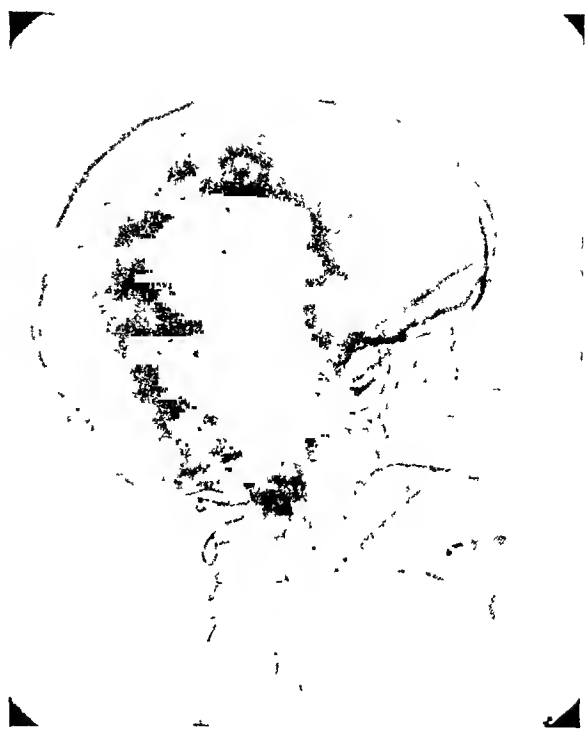


Fig. 5. Case 2 (November 13, 1930). Roentgenogram showing involvement of the skull. At this time the patient had no headache or other symptoms referable to the central nervous system. No radiation has been given to the skull.

*History.*—A lump in the right breast was first observed two and one-half years previously, and was permitted to grow undisturbed until six months before admission, when the odor from an ulceration attracted the attention of the patient's sister.

*Examination.*—An area of ulceration, 9 cm. in diameter, surrounds and includes the nipple area. Underlying the ulcer is a hard, irregular mass about 20 cm. in diameter. The right axillary lymph nodes are large and hard.

*Operation.*—On August 17, 1928, under colonic ether anesthesia, a radical mastectomy, with a Thiersch skin graft, was performed, including a wide area of skin beyond the ulcer.

*Pathological Report.*—Diffuse, cellular carcinoma of the breast and axillary lymph nodes.

*Result.*—A few small skin nodules appeared ten months after the operation. These disappeared under X-ray therapy



Fig. 6 (November 22, 1928). This patient was operated upon March 9, 1927, for cancer of the breast, with extensive axillary node involvement. At the time of operation it was necessary to resect a portion of the axillary vein in order to remove all of the gross metastatic tumor. No more than the usual swelling resulted and there was no circulatory disturbance.

The patient lived without subjective symptoms until March 13, 1930 (nineteen months), when she died suddenly, the cause of death being unknown; no autopsy was performed.

Case 2 (83,059).—A female, white, forty-eight years of age, was admitted to St. Luke's Hospital, September 8, 1930.

*History.*—An incomplete operation for carcinoma of the upper outer quadrant of the breast was performed one year previously in another hospital, with a local recurrence three months later. The patient complained of excruciating pain in the left hip, radiating down the left thigh, for four months, and, with her strength gradually failing, she is now practically bed-fast.

*Examination.*—The patient's complexion is pasty, and she appears ill. There is a hard mass about 6 cm. in diameter underlying the scar at the site of operation. It is fixed to the skin and to the chest wall. The right axillary nodes are large and hard, but not fixed. Marked tenderness is present in

the left gluteal region and along the posterior surface of the left thigh.

*X-ray Reports.*—There is extensive bone involvement of the lumbar spine and left ilium. The first and second lumbar vertebrae show extensive destruction (September 9, 1930).

There is a pathologic fracture of the left clavicle at the junction of the middle and outer third (October 9, 1930).

The condition of the spine and pelvis is unchanged. Foci of involvement are seen in the left humerus, left radius and ulna, and in the upper thirds of both femurs. The skull (Fig. 5) shows marked invasion (November 13, 1930).

*Treatment.*—The patient received intensive deep X-ray therapy under the supervision of Dr. Francis Carter Wood, from September 12, 1930, to the present time.

*Result.*—She was able to leave the hospital on December 10, 1930, walking without difficulty and free from pain. When last seen, January 11, 1931, she was still practically free from symptoms. However, there were many large, fixed nodules in her scalp.

#### SUMMARY

The treatment of hopeless cancer of the breast is in any case a discouraging task. It is one, however, which should not be evaded. The morale of the patient is much more likely to be preserved if she does not feel that she is being deserted by her physician. Much can be done to encourage the sufferer and to alleviate discomfort.

Surgery and radiation constitute practically our whole equipment in actually combating the disease. With the marked progress in radiotherapy, there has been a tendency to overlook the value of surgery. It has a definite place in the palliative treatment as well as in the cure of cancer. Jackson and Minot (12) have pointed out

many ways in which purely medical treatment may add to the comfort and general wellbeing of the cancer patient.

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## PAGET'S DISEASE OF THE BONE

By HARVEY SMITH, M.D., HARRISBURG, PENNSYLVANIA

PAGET'S osteitis deformans is usually described as a "chronic, slowly progressive disease involving one or more bones of the body and causing certain structural changes which result in an increase of size and thickness." When the diseased bone happens to be the tibia or femur, changes in contour, curvatures, and pathologic fractures are not infrequent. As a basis for this discussion of some of the clinical aspects of this disease, I shall briefly report three such cases.

Case 1. P. W., a male, aged 52, was admitted to the Harrisburg Hospital September 15, 1924, with fracture of the right leg. While playing tennis he felt a "snap" in the leg, following which there was not much pain, but he was unable to walk. The X-ray films showed a fracture of the upper third of the right tibia, the parts in good position. The films also showed a cystic condition of the upper two-thirds of the tibia, with much thickening and bone proliferation, and arching and bowing of the tibia. The X-ray diagnosis was pathologic fracture and Paget's disease. No other bones were involved.

There had been a gradual increase in the size of this leg, associated with some pain, for four years prior to the fracture. Otherwise the man's general health was excellent. The Wassermann was negative.

About three months after the accident the patient was referred to Dr. Bloodgood for an opinion as to subsequent management, because of the delayed union, probable non-union, and possible malignancy. Dr. Bloodgood showed films of this case during one of his morning sessions, and told his hearers why he advised amputation of the leg.

Paget, in his original paper, noted the association of bone malignancy with osteitis deformans. Codman, in his recent investigation of bone tumors, found that 14 per

cent of all cases of Paget's disease die of osteogenic sarcoma. A still more recent report from the Bone Registry of the American College of Surgeons says that 5 per cent of osseous sarcomas begin in bones involved in the type of pathology under discussion. If we are to believe these statistical reports, the occurrence of bone sarcoma in cases of osteitis deformans is more than a coincidence.

Case 2. G. T., a male, aged 52, was admitted to the Harrisburg Hospital February 9, 1929, with a history of a fall down several steps and an injury to the right hip. X-ray films showed an oblique fracture of the upper end of the shaft of the femur, with shortening and poor approximation of the fragments. The femur above and below the fracture had the mottled cystic appearance of Paget's. No other bones were involved, and the Wassermann was negative. There had been no previous symptoms except pain in the right knee for several months before the accident. The patient was treated as though his was an ordinary fracture, union took place, with much callus, in three months. The man walked with a cane in eight months, and is apparently well at the present time.

Case 3. C. A., a male, aged 59, was admitted to the Harrisburg Hospital, March 2, 1929, with pathologic fracture of the left leg. He had twisted his leg while opening a door. The X-ray examination showed a transverse fracture one inch below the inner trochanter, outward bowing of the femur, and increased thickening and density of the upper two-thirds of the femur. There was no X-ray evidence of Paget's in the right femur, the skull, or the vertebræ. For a year the patient had noticed an outward bowing of the femur, and pain in the left knee. Excessive callus accompanied union in the



Fig. 1. Pathognomonic cranial bone changes in Paget's disease. Note the thick finely porous outer table, covered by small bony nodules. (X-ray examination by Dr. Ritzman.)

bone in six months, and the man walked in twelve months.

The diagnosis of Paget's in these three cases was made from the X-ray films after fractures following slight injuries. Like all patients with this disease, there was an absence of definite characteristic symptoms in the early stages. Pain was the one common symptom, because the lesions happened to be in the extremities. In this early stage there is no diagnostic clinical picture. Physical examination may show no cause for the complaints, and months may pass before the X-ray examination shows bone changes. Some cases are free from all subjective symptoms and note only the slow, gradual increase in size of the bone. This explains why an early positive diagnosis is difficult, and often not made at all. In the cases reported, there were no secondary anemias and the Wassermanns were negative. The relationship of syphilis and osteitis deformans has been a freely discussed question, and it is generally believed their association is incidental and in no way related. There was no blood chemistry done in these cases. In a recent review of

twenty-one cases this phase was discussed by Bortz, of Philadelphia, and he was not able to demonstrate any constant findings.

The clinical diagnosis is comparatively



Fig. 2. The irregular thickening of the long bones in Paget's disease. Note the anterior bowing and multiple bone cysts. (X-ray examination by Dr. Ritzman.)

easy when there is cranial and multiple bone involvement, with the classical structural changes of the later stages. These changes in the skull are pathognomonic and familiar to all—the gradual general enlargement, undue prominence of the frontal bones, and non-involvement of the face. The bone is several times normal thickness, without encroaching upon the skull cavity. There is a finely porous outer table (area of rarefac-



## PAGET'S DISEASE OF THE BONE

By HARVEY SMITH, M.D., HARRISBURG, PENNSYLVANIA

PAGET'S osteitis deformans is usually described as a "chronic, slowly progressive disease involving one or more bones of the body and causing certain structural changes which result in an increase of size and thickness." When the diseased bone happens to be the tibia or femur, changes in contour, curvatures, and pathologic fractures are not infrequent. As a basis for this discussion of some of the clinical aspects of this disease, I shall briefly report three such cases.

Case 1. P. W., a male, aged 52, was admitted to the Harrisburg Hospital September 15, 1924, with fracture of the right leg. While playing tennis he felt a "snap" in the leg, following which there was not much pain, but he was unable to walk. The X-ray films showed a fracture of the upper third of the right tibia, the parts in good position. The films also showed a cystic condition of the upper two-thirds of the tibia, with much thickening and bone proliferation, and arching and bowing of the tibia. The X-ray diagnosis was pathologic fracture and Paget's disease. No other bones were involved.

There had been a gradual increase in the size of this leg, associated with some pain, for four years prior to the fracture. Otherwise the man's general health was excellent. The Wassermann was negative.

About three months after the accident the patient was referred to Dr. Bloodgood for an opinion as to subsequent management, because of the delayed union, probable non-union, and possible malignancy. Dr. Bloodgood showed films of this case during one of his morning sessions, and told his hearers why he advised amputation of the leg.

Paget, in his original paper, noted the association of bone malignancy with osteitis deformans. Codman, in his recent investigation of bone tumors, found that 14 per

cent of all cases of Paget's disease die of osteogenic sarcoma. A still more recent report from the Bone Registry of the American College of Surgeons says that 5 per cent of osseous sarcomas begin in bones involved in the type of pathology under discussion. If we are to believe these statistical reports, the occurrence of bone sarcoma in cases of osteitis deformans is more than a coincidence.

Case 2. G. T., a male, aged 52, was admitted to the Harrisburg Hospital February 9, 1929, with a history of a fall down several steps and an injury to the right hip. X-ray films showed an oblique fracture of the upper end of the shaft of the femur, with shortening and poor approximation of the fragments. The femur above and below the fracture had the mottled cystic appearance of Paget's. No other bones were involved, and the Wassermann was negative. There had been no previous symptoms except pain in the right knee for several months before the accident. The patient was treated as though his was an ordinary fracture, union took place, with much callus, in three months. The man walked with a cane in eight months, and is apparently well at the present time.

Case 3. C. A., a male, aged 59, was admitted to the Harrisburg Hospital, March 2, 1929, with pathologic fracture of the left leg. He had twisted his leg while opening a door. The X-ray examination showed a transverse fracture one inch below the inner trochanter, outward bowing of the femur, and increased thickening and density of the upper two-thirds of the femur. There was no X-ray evidence of Paget's in the right femur, the skull, or the vertebræ. For a year the patient had noticed an outward bowing of the femur, and pain in the left knee. Excessive callus accompanied union in the



Fig. 1. Pathognomonic cranial bone changes in Paget's disease. Note the thick finely porous outer table, covered by small bony nodules. (X-ray examination by Dr. Ritzman.)

bone in six months, and the man walked in twelve months.

The diagnosis of Paget's in these three cases was made from the X-ray films after fractures following slight injuries. Like all patients with this disease, there was an absence of definite characteristic symptoms in the early stages. Pain was the one common symptom, because the lesions happened to be in the extremities. In this early stage there is no diagnostic clinical picture. Physical examination may show no cause for the complaints, and months may pass before the X-ray examination shows bone changes. Some cases are free from all subjective symptoms and note only the slow, gradual increase in size of the bone. This explains why an early positive diagnosis is difficult, and often not made at all. In the cases reported, there were no secondary anemias and the Wassermanns were negative. The relationship of syphilis and osteitis deformans has been a freely discussed question, and it is generally believed their association is incidental and in no way related. There was no blood chemistry done in these cases. In a recent review of

twenty-one cases this phase was discussed by Bortz, of Philadelphia, and he was not able to demonstrate any constant findings.

The clinical diagnosis is comparatively



Fig. 2. The irregular thickening of the long bones in Paget's disease. Note the anterior bowing and multiple bone cysts. (X-ray examination by Dr. Ritzman.)

easy when there is cranial and multiple bone involvement, with the classical structural changes of the later stages. These changes in the skull are pathognomonic and familiar to all—the gradual general enlargement, undue prominence of the frontal bones, and non-involvement of the face. The bone is several times normal thickness, without encroaching upon the skull cavity. There is a finely porous outer table (area of rarefac-

tion) covered with small nodules of bone. This X-ray appearance has been likened to the "kinky hair of the negro." No other bone lesion produces this picture.

The long bones in Paget's disease are large, thick, rough, irregular, with anterior or lateral bowing, and contain many multiple cysts from bone absorption. When the vertebræ are involved there is anterior bow-

ing of the spine as a result of these same bone changes.

The following theories have been advanced as to etiology: (1) A chronic irritative process within the bone (toxic infection); (2) a defective calcium metabolism (parathyroid dysfunction); (3) heredity. None of these is satisfactory and none is of more than merely academic interest.

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**A Roentgenologic Study of the Breast.**  
Stafford L. Warren. *Am. Jour. Roentgenol. and Rad. Ther.*, August, 1930, XXIV, 113.

As the title indicates, this paper is primarily a roentgen study of the normal and pathological breast. The author describes a simple standardized technic which he believes will be absolutely diagnostic in some types of cases and of considerable assistance in others. The technical factors recommended are: 185 milliampere-seconds, 25 inch target-film distance, Potter-Bucky diaphragm, double screens, and from 50 to 60 kilovolts. The opposite side is always taken for a comparative study, and each side is studied stereoscopically.

The author describes and gives illustrative roentgenograms of the normal breast, changes due to pregnancy, breast abscess, chronic mastitis, benign and malignant tumors. The normal breast usually has from 5 to 8 ducts, extending from the nipple region downward to the base. The breast lobules stand out from the fatty masses, which are relatively transparent. The base of the breast is sharply separated from the pectoralis muscles by a definite line or septum. Breast abscess shows a uniformly

dense localized mass, together with a generalized haziness, indicating the associated generalized inflammatory process. Benign tumors are clearly demarcated from the surrounding tissues and are usually of homogeneous density. In malignant tumors there is a dense sheet or mass, with irregular edges and feathery strands of dense tissue invading the ducts and lobules, with puckering and distortion of these normal structures.

The comparative accuracy of the cases studied by the author is shown by a tabulation in which 119 cases diagnosed by X-ray films were correct and *only* 8 cases incorrect; 45 cases were proved by operation or autopsy. On the basis of the studies made, the author concludes that: (a) stereoscopic roentgenographic study of the normal breast, whether obese or atrophic, conforms to the anatomical structures which are present; (b) abnormalities, visible in such films, also correspond very closely to the gross appearance of such abnormalities; (c) the diagnosis from the films of the breast corresponds very closely to the operative and autopsy findings.

J. E. HABBE, M.D.

# THERAPY WITH LONG WAVE LENGTH X-RAYS (GRENZ RAYS)<sup>1</sup>

By FRANCIS CARTER WOOD, M.D., and GEORGE M. MACKEE, M.D.

NEW YORK

IT has long been known that the commercial X-ray tube emits practically no X-rays when run at a voltage of 10 kilovolts or less. The reason for this is that the glass of which the tubes are made has a high absorptive power for the long wave length X-rays. If 10 kilovolts is taken as the limiting value for the voltage, the shortest wave length of the X-rays which are excited is given by the well known Duane formula, which is: The shortest wave length in Ångström units equals 12.35 divided by the peak voltage in kilovolts. This value is obviously 1.235 Ångströms. Longer wave lengths than this are retained by the glass.

Many years ago, Lindemann showed that if a lithium borate glass was used, and the thickness kept low, X-rays of considerably longer wave length would escape from the tube than with ordinary glass. As the lithium glass is difficult to handle, it is usual to make the tube of ordinary glass and insert a small window of lithium glass opposite the anticathode, though Bucky has designed a tube wholly composed of lithium borate glass. The construction of such tubes does not vary in principle from that of ordinary tubes. The anticathode is made of tungsten or an iron-chromium alloy and the electron stream is derived from a hot cathode as in the usual Coolidge construction. Water cooling of the anticathode is usual, as it greatly increases the tube output. Under these circumstances, radiation from 1 to 3 Ångströms appears in quantity outside the X-ray tube, though probably at least 50 per cent is absorbed even in the lithium glass window. The lithium glass is not absolutely essential. If the wall of the tube is kept thin enough, such long wave length

X-rays as mentioned will penetrate in large quantities, but tubes with thin glass windows are difficult to handle from the mechanical aspect. X-rays of the longer wave lengths are rapidly absorbed in the air. Of those of 2 Ångströms, 20 per cent is absorbed in a 10 cm. thickness of air, the corresponding absorption for 3 Ångströms being 40 per cent. It is necessary, therefore, in practice, to make accurate measurements of the skin-focus distance, and it may even be advisable to filter the radiation with very thin aluminum foil, properly supported, in order to get a little more homogeneous radiation. It is obvious that if 20 per cent of the shorter wave lengths is absorbed in 10 cm. of air, the absorption in the skin will be much higher. As a matter of fact, the radiation of 3 Å.U. loses half its value in penetrating at a maximum 0.2 mm. of the skin, while that of 2 Å.U. loses half its value at approximately 1 mm. below the skin surface. This does not mean that a certain amount of the shorter wave lengths will not have a considerable range, and this is shown by the fact that it is possible to take excellent pictures of the bones of the hand with such radiation. Also the grain structure of a piece of pine wood 2.5 cm. thick is well brought out by a short exposure with such a tube, giving much more detail than is ordinarily obtained with higher voltages.

The clinical measurement of these long rays can be carried out either by the use of the Sabouraud pastille, with the inaccuracies incident in such determinations, or by a specially constructed ionization chamber of the thimble type. The chief point is that the walls of the chamber be thin enough so that the radiation is not largely absorbed before it reaches the air of the chamber. In well equipped laboratories the measurements can

<sup>1</sup>Reprinted by permission from the *Journal of the American Medical Association*, Jan. 10, 1931, XCVI, 111.

be made, of course, with an open ionization chamber such as is used as a standard in determining the roentgen unit.

#### BIOLOGIC EFFECTS

As the action of these super-soft, infra-roentgen, or Grenz rays, as Bucky has called them, is wholly atomic, despite their long wave lengths, it would be expected that they would follow the quantitative laws already established for the biologic action of radiation by Wood and Packard. In fact, Packard has recently shown with the eggs of *Drosophila* that the biologic action of the soft X-rays of the type under consideration is the same as X-rays of short wave length or gamma rays of radium, the lethal curves superimposing exactly. Clinically, however, the biologic effect may be expected to be somewhat different from that of shorter wave lengths, owing to the fact that the absorption takes place largely in the first few millimeters of the skin. Consonant with this fact, the histologic changes produced have been described as slightly different from those following radiation of the shorter wave lengths, the lesions being somewhat less marked in the vessels and characterized chiefly by proliferation of the connective tissue and certain changes in the stratum granulosum of the epidermis. But it is doubtful whether there exists any fundamental difference between the reactions following the application of any wave length of X-rays to the skin.

#### APPARATUS

The exciting apparatus may be a step-down transformer, the current for which is obtained from a modern interrupterless X-ray transformer; or, as is usually the case, a special transformer, designed to supply

a maximum of 10 kilovolts and 10 milliamperes, is employed. The principle of such a transformer does not differ from that of generators used for short wave X-rays. It is simply a high-tension transformer with a closed iron core. The high-tension transformer is regulated by both autotransformer and resistance control. One of the high tension lines is grounded. There is a small step-down transformer to supply suitable current for the Coolidge filament. A kilovoltmeter and milliamperemeter are built into the switch board. The apparatus has not yet been standardized. Some machines include a thermionic rectifier (kenotron tube) while others deliver an unrectified current. The transformer, with its accessories, is housed in a small cabinet on which is mounted the switch board, controls, tube stand, and the water-cooling device for the tube. The apparatus is designed for use with commercial alternating current. If only direct current is available, a small rotary converter may be installed in the cabinet.

#### TUBE

The special tube that is most popular for the purpose is a small, water-cooled, uni-polar, hot cathode glass tube which, with the exception of the Lindemann glass window, is encased in a metal housing. The tube is delicate; its life is likely to be short. It is important not to touch the Lindemann glass window.

Bucky and Glasser estimate the wave lengths obtained with this special tube and apparatus operating on about 8 kilovolts as ranging from 1.6 to 2.06 Ångström units. The average is about 2 Ångström units. Ultra-violet rays have wave lengths between 4,000 and 15 Ångström units. X-ray wave lengths range from about 15 Ångströms to about 0.06 Ångström. X-ray wave lengths commonly used in radiotherapy are between

0.3 and 0.06 Ångström units. The Grenz rays, therefore, fall well within the X-ray spectrum, but their average length is greater than that previously used for therapeutic purposes. Bucky estimates the longest X-ray wave lengths heretofore employed therapeutically at about 1 Ångström average.

#### CUTANEOUS REACTIONS

Because of the knowledge of the biologic action of X-rays of various wave lengths, radium, and ultra-violet rays, and particularly the beta rays of low velocity, cathode rays and very soft secondary rays from heavy metals, the biologic effect of Grenz rays is exactly what would be expected. Depending on the size of the dose, cutaneous reactions vary from simple erythema (redness) to vesiculation and erosion, with exudation and crusting. Because most of the radiation (assuming that it has an average wave length of 2 Å.U.) is absorbed by the epidermis and upper layers of the derma (depending considerably on the thickness of the skin, which varies markedly with location and disease), the deep derma and subcutaneous tissues are not likely to be seriously damaged with amounts recommended for therapeutic purposes. Therefore, no deep, indolent, painful ulcers that are so characteristic of third-degree roentgen and radium ulcers have yet been reported. While delayed reactions occur, it is customary for the erythema to appear within twenty-four hours. Regardless of the intensity of the reaction, inflammation usually disappears in a few weeks: deep pigmentation, however, often endures for many months. Several times the erythema dose may be given at one sitting without effecting epilation, although if the dose is sufficiently large, epilation occurs. Four and even six times the erythema dose of short wave length X-rays has been administered to

small areas without provoking more than a mild second-degree reaction. A larger amount is apt to cause a serious third-degree reaction. The Grenz-ray erythema dose has been increased considerably more than this without effecting more than an intense erythema, superficial edema, and pigmentation, with, at times, vesiculation, erosion, exudation, and crusting.

Sequelæ thus far have been uncommon. A few cases of mild atrophy and telangiectasia have been reported. Sufficient time has not yet elapsed, and too few patients have been treated, to allow one to estimate accurately the possibility of sequelæ or to determine the possible danger of small and large doses repeated over a considerable period. However, it can be said that Grenz-ray therapy is much safer than therapy with shorter wave lengths, for both deep and superficial tissues. This is especially true for unskilled operators: either method is safe when properly employed. The safety factor in Grenz-ray therapy depends principally on using a tension below 10 kilovolts, preferably about 7 or 8 kilovolts.

#### TECHNIC

As with short wave length X-rays, Grenz-ray dosage may be estimated by the direct method (photographic and pastille radiometers; spectrometer; electrostatic voltmeter; iontoquantimeter; biologically with seeds or larvæ), or by the indirect method (milliamperage, voltage, time, and distance), or by a combination of the two. Although being improved and simplified rapidly, it will be some time before iontoquantimeters and spectrometers are practicable for the daily routine use of the busy practising physician; therefore, the direct method is not popular in this country either for Grenz rays or for shorter wave length X-rays. In the near future the combined

method is likely to be the choice, but possibly not until there is a larger number of capable physicists. For the combined method it is customary to have a physicist standardize a given apparatus and tube in terms of peak voltage, wave length, roentgen units, and erythema dose; in other words, quantity and quality expressed in milliamperage, voltage, time, and distance. An amount over 200 or 300 roentgen units (half absorption value 0.036 mm. of aluminum) is likely to cause mild erythema. The quantity required for the erythema dose varies considerably with different authors because there is no definite clinical, biologic, or instrumental standard for the erythema dose. Some place it as low as 200 r; others as high as 500 r or even higher. The technic should be checked frequently in the manner mentioned; also every time a new tube is used, an old tube repaired, or when any change is made in the installation. For daily use the operator depends on the four established constants, namely, milliamperage, voltage, time, and distance.

Most operators in this country utilize the indirect method of estimating X-ray dosage regardless of wave length; Grenz rays are included in this statement. They establish the four constants (milliamperage, voltage, time, and distance) for the erythema dose. The voltmeter is first calibrated for peak voltage by means either of a sharp-pointed or of a small sphere spark gap, preferably the latter. This is done by the manufacturer and should be checked occasionally. Eight kilovolts, with 8 milliamperes, will give an average wave length of approximately 2 Å.U. (half absorption value 0.036 mm. of aluminum). The working distance is 6 centimeters. The time factor is obtained by applying the radiation produced by the constants mentioned to small areas of skin on some fairly sensitive part, such as the flexor surface of the forearm of a young adult, in increasing amounts until erythema is evoked. The time is then recorded and

added to the other constants. This is called (arbitrarily) the skin unit. Most operators in this country employ the following constants for the erythema dose: 8 milliamperes; 8 kilovolts; 4 minutes at 6 cm. distance. This gives approximately 370 roentgen units (Glasser). These are sea-level values; they may be high for high altitudes. The time factor may be divided for fractional treatments and multiplied for massive dosage. All other factors should remain fixed. A change in any one will necessitate a change in one or more of the others.

Roughly, most of the technical rules relating to shorter wave length X-rays pertain to Grenz-ray therapy; variations in skin toleration due to age, sex, complexion, location, thickness of skin and its various layers, especially the horny layer; disease; idiosyncrasy; impossibility of obtaining an erythema color standard or index; increase of erythema or other visible biologic effect not proportional with increase of quantity or quality of radiation; possible accumulative action of repeated applications; avoidance of extremely large doses, at least until more is known relative to the possibility of undesirable late results. There are exceptions: Grenz rays produce less scattering and fewer secondary rays than do shorter wave lengths; therefore there is less difference in detectable effect when the radiation is applied to large areas as compared to small areas. Because these long wave lengths are absorbed by air, it is necessary to place the tube close to the skin; also distance must be accurately measured and maintained because the percentage of error at a short distance is considerably greater than at the working distance of 8 or 10 inches ordinarily employed with shorter wave lengths. It is advisable to shield the skin immediately around the treated area with thin lead foil. Radiation passes through only the Lindemann glass window; it does not travel far and it does not excite much secondary radia-

tion, therefore it is unnecessary to protect especially the patient's body or the operator.

### THERAPEUTIC RESULTS

While the radiation is a valuable therapeutic agent, it is less efficacious, less versatile, and more time-consuming than X-rays of shorter wave length. In spite of the higher degree of safety, the method is not yet suitable for use by any but those who have been adequately trained in X-ray work.

The best field for Grenz-ray therapy is in dermatology. Here, the results have been good, at least in many diseases. It is especially suitable when it is necessary to avoid temporary or permanent injury to important organs and to glandular apparatus in or under the true skin—hair roots, sebaceous and sweat glands, testes, eyes. Even here there are limitations; with heavy dosage or repeated applications, enough of the shorter wave lengths (contained in the heterogeneous beam) may be absorbed by tissue below the epidermis to effect undesirable and perhaps serious injury. However, the method is comparatively safe and very useful for patches of various dermatoses located on the scrotum, eyelids, and scalp—eczema, psoriasis, lichen planus, lupus vulgaris, and basal-cell epithelioma.

With tubes available at present, used at a skin-target distance of 6 cm., the exposed area of skin is a circle having a diameter of about 4 centimeters. Obviously, the method is not suitable for the irradiation of universal, generalized, or extensive eruptions.

Published reports of therapeutic results are yet rather meager and they come from comparatively few workers. Most of the favorable results have been obtained with large doses (erythema dose to several or many times the erythema dose—from 300 or 400 to 3,000 or 4,000 roentgen units administered at one time and repeated, if nec-

essary, at intervals of from one to several months). There has been little experience with fractions of the erythema dose administered once weekly. Thus far fractional treatment has not been especially successful. In general, it is doubtful whether any skin disease (not an individual case) can be cured with Grenz rays that cannot be cured with X-rays of shorter wave lengths or with beta rays of radium. Occasionally, a patch of some inflammatory dermatosis, such as eczema or psoriasis, that is not favorably influenced with very conservative treatment with X-rays of shorter wave length will yield to a massive dose of Grenz rays; more often, shorter wave lengths succeed when Grenz rays fail.

Good results have been obtained in some of the following conditions: patches of eczema of all types, patches of lichen planus and psoriasis, localized essential pruritus, perlèche, warts of various types, lupus vulgaris, Bazin's disease, tuberculosis, verrucosa cutis, scrofuloderma, basal-cell epithelioma, superficial cavernous angioma, strawberry mark, port-wine mark, boils, Kaposi sarcoma, sarcoma of various types, dermatitis herpetiformis, paronychia, ringworm of scalp and skin, acne varioliformis, Darier's disease, mycosis fungoides, and poikiloderma. Poor results have thus far followed the use of Grenz rays in sycosis, xanthoma, acne vulgaris, keloid, dermatitis papillaris capillitii, alopecia areata, prickle-cell epithelioma, tuberculid, and scrofuloderma. With few exceptions the Grenz rays have not yet been tried for skin diseases other than those mentioned.

Bucky presented two cases of port-wine mark before the New York Dermatological Society in January, 1930. A portion of each lesion had been treated with heavy doses of Grenz rays. The treated parts were distinctly paler than the untreated areas. Since then several dermatologists have endeavored to eradicate port-wine marks with massive doses of Grenz rays



without success. It is possible that failure is due to conservatism: several or many large doses are required and until such treatment is proved to be without danger cautious dermatologists hesitate to accept the risk. Bucky employs doses of 4,000 r at intervals of two months.

Several dermatologists have obtained results in lupus vulgaris that seem superior to those possible with shorter wave lengths. However, the difficulty just now is that reports of success and failure are, for the most part, based on too few cases, in many instances only one or two patients having been treated. For this reason and because greater technical knowledge is required, several years must elapse before it will be possible to give an accurate or even fair evaluation of the method. Judging by present knowledge, Bucky's prediction that Grenz rays will replace X-rays of shorter wave length in dermatology is too optimistic.

Attempts have been made to influence various internal diseases by applying Grenz rays to eight areas on the trunk. The same method (so-called general or indirect treatment in contradistinction to direct irradiation of lesions) has been used, also, for some skin diseases, especially those that involve extensive surfaces, those that are characterized by remissions and exacerbations, and those that are definitely due to some general disturbance. The *rationale* of indirect treatment is based on the fact that radiation of various kinds (X-rays, radium, ultra-violet rays) if properly employed will at times provoke temporary leukocytosis (leukocyte sturz); also that through the autonomic nervous system such radiation may affect the endocrine glands, general nervous system, general circulation, metabolism, or vitamins. Bucky believes that the Grenz rays are more efficacious in this respect than radiation of any other wave length. He gives the following technic for indirect treatment: The torso is divided into four areas, front and back (eight in

all). On each of eight successive days one field is irradiated at a distance of 15 cm. with from 150 to 300 roentgen units. When the series is completed a second series is given, following the original sequence, but making the exposures every second day. The two series constitute a course of treatment. As a rule, several courses are administered with intervals of rest depending on indications.

Good results for the indirect Grenz-ray treatment are claimed for gastric ulcer, gastric hyperacidity, Banti's disease, polycythemia rubra, hypothyroidism, dysmenorrhea, oligomenorrhea, amenorrhea, hypertrichosis, asthenia, arthritis deformans, asthma, pertussis, angina pectoris, and spastic constipation. Exophthalmic goiter, Hodgkin's disease, and leukemia are not favorably influenced. Indirect treatment was used successfully in a number of skin diseases: acne vulgaris, acne rosacea, universal erythroderma, and urticaria. The effect on acne rosacea is said to be especially good.

The results of indirect Grenz-ray treatment have not yet been corroborated to any extent; also, only a few cases of each disease have been reported. The method and particularly the explanation for the alleged good results have been received with considerable skepticism. It will be necessary to compile statistics from a number of clinics over a period of years before the value of indirect treatment can be ascertained.

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# EXPERIMENTAL HYPERTHERMIA INDUCED BY THE HIGH FREQUENCY CURRENT

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## PART 1.—EXPERIMENTS WITH DIATHERMY

IN connection with a study of the use of diathermy in the treatment of general paresis (1) we were enabled to make a comparison of the effects of hyperthermia induced by this method with the results of exposure to a vacuum tube oscillator. The narrow frequency range of the diathermy machine and the physical limitations to its use have restricted its application biologically.

The modern development of the vacuum tube oscillator has opened up a new field, since its use has made possible the investigation of frequencies ranging from 1 million to 158 million and more cycles per second. Very little analytical work has been done on the biological effects of these currents, but it is believed that they differ fundamentally from those produced by any other type of electric current.

Our first experiments were with the diathermy current; the second part of the work was done with the vacuum tube oscillator.<sup>1</sup> The diathermy was tried on human subjects (paretics) and on dogs.

*Experiments on Humans (1).*—The successful treatment with diathermy depends on certain mechanical factors necessary to produce a rise of temperature, to maintain it, and to prevent burns in the patient. The prime requisites are properly constructed electrodes, a machine powerful enough to deliver sufficient energy, and proper insulation of the subject. The electrodes must have a long edge because the current tends

to concentrate along the edges. Fenestrated electrodes accomplish this. Furthermore, when large surfaces of the body are subjected to heavy doses of diathermy current, between 4,000 and 6,000 milliamperes, varying resistances are encountered, depending largely upon thickness. In order to force 6,000 ma. through the body with safety the electrodes must be as large as possible. The entire back must be covered by one electrode and the entire chest and abdomen by another.

The current was applied in such a manner that the maximum temperature (103°–104°F.) was reached after from 3 to 4½ hours. Rectal and mouth temperatures were taken every fifteen minutes. Blood was drawn just before the current was applied, and immediately after the treatment. For the carbon dioxide determinations the blood was collected under a neutral mineral oil.

*Results of the Blood Analyses.*—Determinations were made of blood chlorides, serum calcium, CO<sub>2</sub> combining power of the plasma, non-protein nitrogen, and uric acid. Six patients in all were examined throughout the entire course of treatment. Non-protein nitrogen and uric acid were determined in only one patient in a course of ten treatments.

*Blood Chlorides.* Determined by the Van Slyke modification of the Whitehorn method. There was about a 10 per cent increase, which may have been due to the increased concentration of the blood.

<sup>1</sup>The machine was a standard type very kindly furnished us by the Victor X-ray Corporation.

*Serum Calcium:* Determined by the Clark-Collip modification of the Kramer-Tisdall method. There was about the same percentage of increase as in the chlorides. In some samples, however, the initial calcium value was abnormally low and for this we are unable to account.

*Carbon Dioxide Capacity of the Plasma:* By the Van Slyke and Cullen method. There was a marked decrease in the  $\text{CO}_2$  combining values after treatment, amounting to as much as 20 per cent. The non-protein nitrogen increased about 10 per cent, and the uric acid increased about 20 per cent.

In a recent paper by Bischoff, Ullmann, Hill, and Long (2) diathermy experiments were tried on six normal individuals. The time of exposure varied from  $1\frac{1}{2}$  to  $3\frac{1}{2}$  hours. Analyses were made of plasma pH, total  $\text{CO}_2$  content, phosphorus, calcium, oxygenation of hemoglobin, and urine pH. These investigators report a slight but definite increase in plasma pH, and a decrease of from 4 to 12 volumes per cent in the total  $\text{CO}_2$  content of the blood. Also the pH of the urine remained unchanged or increased, inorganic phosphorus unchanged or decreased, and the hemoglobin more or less highly oxygenated. They explain that the change in the total  $\text{CO}_2$  content of the blood is readily accounted for by the shift of base to the blood proteins because of the increase in pH. The fall in the total  $\text{CO}_2$  content may or may not signify a lowered alkali reserve, since the pH of the plasma and oxygenation of the hemoglobin have both increased. Semiquantitative calculations which these investigators carried out indicate no change or a slight increase in the alkali reserve.

*Experiments on Dogs.*—In the application of the diathermy current to the unanesthetized dog we experienced difficulty in preventing body burns around the edges

of the electrodes, so that it was impossible to give an animal more than one or two exposures. The dogs were held comfortably in a stock and the electrodes fastened to either side of the thorax. The current was increased gradually until the temperature had risen 4 or 5 degrees F. and then maintained for an hour. Table I shows the blood changes.

It is the growing belief of workers in this field that the effects produced on animals can be fully explained on the basis of the heat generated by the high frequency currents which are induced in them. Thus the chemical changes in experimental hyperthermia should, on this basis, tally closely. In this connection it is interesting to compare results obtained by different methods. Hall and Wakefield (3) studied the effects of heat on the animal organism, and also determined the blood changes. They fitted up a wooden chamber containing a radiator, an electric fan, and wet and dry bulb thermometers. Dogs were exposed in this chamber for from 12 to 75 minutes. The temperature of the chamber as indicated by the dry bulb was about 138 degrees F., of the wet bulb 104 to 112 degrees F., and the rectal temperature of the dogs after the exposure was about 112 degrees F. Blood for analysis was collected under oil from the jugular vein. Determinations were made of NPN, urea N, uric acid, creatinine, sugar, chlorides,  $\text{CO}_2$  combining power, lactic acid, serum pH, inorganic P, calcium, and total N. Hall and Wakefield commented on their results as follows: "Following exposure, the experimental animals reacted with the clinical syndrome of heat exhaustion as well as that of thermic fever, indicating the common etiology of these two types of reaction. Blood chemistry observations and pathologic changes indicate great renal injury; the alkali reserve decreased markedly, the lactic acid increased more than 300 per cent, the serum pH decreased, emphasizing the un-

compensated nature of the acidosis." They report also an increase in non-protein nitrogen, calcium, and chlorides.

A comparison of these results on dogs with those obtained by us and by Bischoff and his co-workers on humans, if such a comparison is justifiable, shows agreement except on two values, namely, change in pH and alkali reserve. Bischoff reports that in their human subjects the pH shifts to the alkaline side, and that there is no change or only a slight increase in the alkali reserve. Hall and Wakefield report in their dogs that the pH shifts to the acid side, and that there is a marked decrease in the alkali reserve. The final temperature of their dogs, however, was higher than any of Bischoff's subjects, or of ours. We did not determine the pH, but observed a definite decrease in the plasma CO<sub>2</sub> combining power in both man and dogs. Discrepancies or differences in the effect of hyperthermia on the pH and alkali reserve of the blood are to be expected on the basis of Bazett's (4) discussion of the effect of temperature on the solubility of CO<sub>2</sub>, the dissociation of electrolytes and the base-binding capacities of the blood proteins, and because of variations in the response of the respiratory center and in the muscular activity or restlessness. One would expect an increase in CO<sub>2</sub> combining power because of the increased blowing off of CO<sub>2</sub> due to the hyperpnea, but this did not occur in our experiments.

In a series of papers on an experimental study of diathermy, Binger and Christie and co-workers (5) presented evidence to show that there is a passage of current through the interior of the body, that the diathermy currents penetrate the living cell, and that heat production is intracellular as well as extracellular. They are of the opinion that the effects produced on animals can be fully explained on the basis of the heat generated. There is no evidence yet of any other effect of the diathermy current.

#### SUMMARY

(1) In man, there resulted an increase in blood chlorides, blood calcium, uric acid, and non-protein nitrogen which is best accounted for by the concentration of the blood.

(2) There is a decrease in the CO<sub>2</sub> combining power of the blood, in both man and dogs.

(3) The dogs reacted very much like man with the exception that there was no change or a decrease in the blood chlorides, indicating that in the dogs there is a shift of the chlorides from the blood into the tissues. This appears logical, since the blood chlorides did not increase in the face of a 10 per cent concentration of the blood.

(4) The effects of diathermy current can be explained solely on the basis of heat production.

#### PART II.—EXPERIMENTS WITH THE VACUUM TUBE OSCILLATOR

Recently there have appeared articles dealing with the biological effects of currents of higher frequency. Gosset and his co-workers (6) published, in 1924, a report on the effect on plant tumors of radiations from a vacuum tube oscillating at 150 million cycles per second. They observed that massive exposures to these rays killed various types of plant tumors, death being preceded by an acceleration in their rate of growth. More recently Schereschewsky (7) has studied the effects of these rays on mice. With the apparatus at his disposal he was able to subject mice to lethal exposures at frequencies varying from 8.3 to 135 million cycles per second. He claimed to have shown that the lethality was maximal when the frequency lay between 20 and 80 million cycles. This phenomenon he ascribed to some selective action of these wave lengths, suggesting that this might be in the

form of electromechanical vibration of the living cell caused by the rapid alternations in polarity of the field. He also observed that while the rectal temperature of a live mouse could be raised from 5 to 6 degrees centigrade by these currents, that of a freshly killed mouse could be raised only from 0.1 to 0.7 degree centigrade in a similar length of time. This, he believed, was evidence to show that the heating effect with these currents was different from the diathermic effect observed at lower frequencies.

Having concluded that there might be a differential action upon tissue cells with regard to frequency, Schereschewsky next investigated the effects of these radiations on transplantable tumors. A total of 403 mice with the mouse sarcoma were treated by radiations at a frequency of about 67 million cycles per second—the frequency which he had found to be most lethal to healthy mice. The radiations were strictly localized to the mass of the tumor, so that any systemic effect was excluded. Out of the total of 403 mice treated only 5.5 per cent actually died of the tumor, 23 per cent recovered, and the remainder died from other causes. In 203 control mice, no case of spontaneous recession of the tumor was observed. Somewhat similar results were obtained with chickens that had Rous sarcoma. Microscopic sections of tumors removed after radiation gave a picture resembling coagulation necrosis.

In a small series of experiments a frequency of 135 million cycles was employed, but these radiations were found to have no demonstrable effect on the tumors, which seems to him to support his hypothesis that a specific frequency may be essential.

In short, Schereschewsky thinks that there are certain wave lengths which have a specific lethal action on living cells. This specific band of frequency lies, he says, between 20 and 80 million cycles per second (*i.e.*, between wave lengths of 15 and 3.8

meters). This same band is also supposed to destroy transplantable tumors in mice and frequencies outside this band have no demonstrable effect.

It is known that the physiological effects of alternating currents can be profoundly changed by changes in frequency. D'Arsonval (8) first showed that as the frequency of alternations is increased a point is reached where stimulation no longer occurs, and the subject merely feels a sensation of warmth and prickling in the skin. This critical frequency lies between 5,000 and 10,000 alternations per second, depending on the strength of the current. As the frequency is still further increased, the prickling sensation disappears, till at  $10^6$  cycles per second heat production is the only effect which can be demonstrated. Accompanying the change in the physiological response with an increase of frequency, there is thought to be a change in the path of the current through the tissues. Whereas low frequency alternating currents confine themselves almost solely to the extracellular fluids, at a frequency of  $10^6$  the current actually penetrates the living cell. It does this by reason of the thinness of the dielectric layer surrounding the cell, which transmits the current by means of its capacitance. The heat produced at these frequencies can be wholly accounted for on the basis of ohmic resistance and dielectric loss.

The heating effect of the high frequency waves was discovered more or less accidentally. During developmental research in the General Electric Laboratories on a short wave radio transmitting apparatus heating effects in the vicinity of the antennæ were noted. Miss Hosmer (9) made a preliminary study of the magnitude and characteristics of this heating effect, and found that solutions of different salts, but of the same electrical conductivity, heat alike. She also reported that in rats killed after sublethal treatments the only evidence of tissue dam-



age observed was in the outer layers of the muscle cells of the heart immediately adjacent to the pericardial cavity, and at the tips of the liver lobes.

In view of this knowledge it is interesting to note that Schereschewsky thinks that there are certain wave lengths which have a specific lethal action on living cells. He does not attribute his results to the heating effect accompanying the radiation. His observations, if confirmed, may obviously have a wide range of interest in biology and medicine.

Christie and Loomis, from previous work (5) were convinced that the biological effects of currents of lower frequency could be explained solely on the basis of heat production, and they undertook to find out whether the same was true of currents of higher frequency or whether some specific action on living cells existed. Their experimental work (10) fell into three groups: First, to find if the lethal nature of the radiations was strictly proportionate to their intensity, irrespective of frequency; second, to find if certain frequencies had a specific lethal action on living cells, and third, to find the actual cause of death in animals subjected to these radiations. The results of their experiments are definitely at variance with those obtained by Schereschewsky. They show that the lethal nature of these radiations is proportionate to the intensity of the field up to a frequency of about 50 million cycles. At frequencies higher than this, the lethality of the radiations appears to diminish. It must be realized that the standard of current strength was the intensity of the electromagnetic field and not necessarily the amount of current induced in the mouse. They believe that in this lies the explanation of the apparent diminution in the amount of current induced in it. From Debye's equation for the dielectric constant as a function of frequency and viscosity it is apparent that in the region of

the shorter wave lengths it is possible that the highly viscous elements of the mouse (fat, epidermis, bone) begin to play an important part in its dielectric properties, and either diminish or increase the power loss. At wave lengths less than 6 meters a mouse ceases to behave in the same manner as an electrolyte. Changes in the dielectric constant of the mouse at these very high frequencies would entail a readjustment of the field in the condenser. The results of these experiments certainly do not suggest that any specificity exists with regard to the action of any particular wave lengths on living cells. The lethal effect of these radiations is diminished at the very low wave lengths, but is probably due to less current being induced in the mouse. The lethal effect of these currents can be fully accounted for on the basis of heat production, being generated by the resistance of the tissues and dielectric loss. Lethal doses of the current at all frequencies are accompanied by the same degree of temperature elevation. Heat production in dead mice parallels that in live mice, irrespective of frequency. Sublethal doses given to mice are without ill effects apart from those which can be accounted for by the local accumulation of heat. Animals which are poikilothermic can be given prolonged exposures without any harmful effect, provided the systemic temperature be kept below the lethal point. The effect of these rays on tumors may also in all probability be accounted for on the basis of heat production. Schereschewsky states that the tumors did not feel hot, but, on the other hand, the microscopic picture of them suggested coagulation necrosis. Direct temperature measurements in the substance of the tumor during radiation would be necessary to rule out the probability that the structural changes observed were not the result of heat.

A histologic study of the tissues of an animal killed by a lethal dose of these ultra-



high frequency waves was made by Baldwin and Nelson (11). They used an oscillating current of from 5 to 6 million cycles under a current strength of from 2 to 4 amperes and 3,000 volts between the plates. Anesthetized albino rats were exposed on alternate days at rectal temperatures of from 40 to 42 degrees centigrade for a period of from ten to thirty minutes. Upon autopsy, they report as observable a definite diminution in the quantity of the body fluids and in blood volume. The ventricles of the heart were filled with clotted blood, usually in complete diastole. The periphery of the lungs, of the heart, and of the liver afforded evidences of an incipient coagulation necrosis. The blood vessels, likewise, in these superficial areas were dilated and filled with clotted blood. In the spleen, liver, kidney, duodenum, and intestines was found cellular mucosal detritus. The capillaries of the intestinal wall were distended and engorged with blood. The stomach, pancreas, sex organs, endocrine and nervous systems appeared normal. Where there was a change it was of the nature of a coagulation necrosis. No evidence was obtained which might afford a basis for the assumption of a selective histologic action of this form of energy. In conclusion, Baldwin and Nelson remark that there exists a striking parallelism between the conditions observed in these experiments and those noted as the results of extreme burns from various sources of external heat, and seem, therefore, to substantiate the conclusions of Christie and Loomis that the changes effected are the result of a true heating condition of the body brought about directly as the result of the oscillating current. Later, Baldwin and Dondale (12) observed the regenerative cycle in adult albino rats subjected to rayings of such intensity that necrotic mucosal conditions prevailed in the intestine. They reported that the regenerative process was begun soon after the last raying and in most instances was com-

pleted by the fifth or seventh day. Ultimately the gut was restored to normal histologic appearance, with no scar formation.

A clear demonstration of the effect of high frequency currents upon a single cell is afforded in the experiments of Kahler, Chalkley, and Voegtlin (13), who exposed suspensions of cultured *Paramecia* to a 4-meter and 30-meter wave. They show that the effect of the high frequency depends primarily upon the production of a rise in temperature in the organism, and offer the following evidence to support their conclusion: (1) Identical behavior of the organism subjected to a gradual rise in temperature brought about by exposure to the high frequency field or direct heating resulted in death in both cases at the same temperature. (2) An absence of any demonstrable biological effect following long continued exposure of the organism to the field at a sublethal temperature, the temperature rise being prevented either by cooling the medium or by suspension of the organism in a non-conducting, non-heating medium. (3) Identical microscopic appearance of an organism killed by exposure in the high frequency field or by ordinary heating. (4) Identical behavior of the organism when exposed to two electric fields differing in frequency. Chalkley (14) later showed that the resistance of *Paramecium* to a temperature of 40 degrees C. varies with the hydrogen ion concentration of the medium.

McKinley and Charles (15) have noted individual variation in response of *Habrobracon juglandis*, a parasitic wasp, to the same dosage in a high frequency electrostatic field. Wasps placed together in the field for the same length of time may be apparently lifeless, normal, or in any intermediate condition at the end of the exposure.

Mellon, Szymanowski, and Hicks (16) have studied the effects of radiations of 1.9 meters independent of the heat factor. Com-

pletely negative results were obtained in attempts to sterilize milk and to destroy bacteria both *in vivo* and *in vitro*. Local radiation to the site of a streptococcus infection in guinea pigs produced no changes in the course of the infection. With diphtheria toxin they report a definite attenuation, as assayed by skin tests in guinea pigs, the toxicity being so diminished that twenty-five skin test doses injected intradermally gave the same reaction as that obtained with one skin test dose of the control toxin. They found that the type of fluid used for cooling was of very great importance.

The vacuum tube oscillator has recently been used to produce fever in man. Carpenter and Page (17) suspended patients between the plates on interlaced tape stretched across a wooden frame. With the patient on his back and the plates on each side they were able to produce a rise of temperature with no visible discomfort, although trouble from arcing was experienced if the plates were above and below. They believe the development of heat is due to the resistance of the body to the conduction of current between the surfaces adjacent to the opposed plates. At each alternation of polarity of the plates the corresponding polarities are induced upon the adjacent boundaries of the interposed body and current is conducted through the material for a brief interval. They have failed to observe any objectionable effects of exposure to the vacuum tube oscillator of frequency 10 million cycles per second unless extremely high temperatures are maintained for long periods.

#### EXPERIMENTAL PART

*Apparatus.*—The apparatus used in our experiments is a vacuum tube oscillator designed by the General Electric Company and loaned to us through the courtesy of Mr. Carl Darnell.

The set is operated from one 110-volt, 60-cycle alternating current main and at normal conditions of operation draws a current of 25 amperes. The power input to the set is then approximately 2.5 kilowatts. An oil-immersed transformer having a 6,500-volt secondary and feeding a full wave rectifier forms the 3,000-volt direct current plate supply for the oscillator. This transformer has a separate winding operating the filaments of the rectifier tubes. An auto-transformer is connected in the primary of the high voltage transformer to provide plate voltage regulation. The rectifier consists of two half-wave hot cathode mercury vapor tubes in conjunction with a filter. A condenser is connected directly across the high voltage d. c. supply. As this condenser provides the peak currents drawn by the oscillator the full plate voltage swing is utilized across the heater plates. The screen-grid voltage for the two PR-861 tubes is supplied from a potentiometer system across the 3,000 volt d. c. supply. (This voltage is approximately 500 volts and is not critical.) Filament power for the oscillator tubes is supplied from a separate transformer. An ammeter is connected in series with the high voltage supply and indicates the total plate current of the oscillator. A shunt feed Hartley circuit operating over a frequency range of from 10,000 to 14,000 kilocycles is used as the oscillator circuit. In this circuit the heater plates are in parallel with the grid and plate coils. The high voltage d. c. is blocked from the heater plates by means of a condenser. A radio frequency ammeter, in series with the heater plates, indicates the current in the tank circuit. The frequency meter consists of a coil tuned by a 125 micromicrofarad, straight line frequency condenser. A neon glow lamp connected to one side of the condenser indicates resonance with the oscillator.

*Experiments on Rats.*—The electrostatic field between the heater plates is not a homo-

geneous one, and as a result the heating effect varies in different parts of the field. We tested the difference in heating effect at different levels in the field. For this purpose a well-ventilated, three-tiered wooden box was constructed, each tier of such dimensions that a 140-150 gram rat could crawl in but could not move from side to side. The rats could be observed through a glass slip plate which closed the front of the box. By means of a support fastened to the top of the cabinet the box was placed always in the same position between the plates.

After an exposure the rectal temperature of the rat in the top tier showed nearly twice the increase of that of the rat in the bottom tier. The rats were approximately the same weight, and the exposure was five minutes. Table II shows a typical result.

In twenty-three such tests the average rise of temperature of the rat in the top tier was 2.66 degrees F., the average rise of the rat in the bottom tier was 1.50 degrees F., and the average rise of the rat in the middle tier was 2.4 degrees F.

*Effect of Daily Hyperthermia on Rats.*—Eighteen rats were given an 8-minute raying daily for a month. The average temperature rise was 3 degrees F. each day. The rats stood the exposure well, on the whole, although during the month three died. Autopsy of these revealed a bronchopneumonia, bilateral, in one case, a bowel obstruction with distended gut and peritonitis in the second, and no gross changes in the third. In these instances death could not be attributed to the high frequency current. A histologic study of the organs of three representatives of the remaining rats was made by Dr. O. R. Caillet, of the Department of Pathology. His report follows:

*Spleen:* A beginning of perifollicular fibrosis. Grossly the spleen does not appear quite as large as normal and the fibrosis is apparently associated with a loss of cellular elements. *Lymph glands:* Some fibrous changes

are also present, but not so marked as in the spleen. *Liver:* There is a slight round-cell infiltration throughout the organ, but no other definite pathology suggestive of any chronic changes. *Kidneys, stomach, and intestine* show no changes.

A few rats were subjected to only one raying and then examined. Those examined immediately after, showed no changes. Those examined twenty-four hours after, showed changes only in the spleen and lymph glands. Four days after, there was a beginning increase in the number of cellular elements, with marked increase of cells undergoing amitotic division. In short, the changes observed in all these rats closely paralleled those observed in rats exposed to high temperature produced by other means (18). In none of our experiments was any evidence of histologic selectivity of this type of current manifested.

#### EXPERIMENTS ON DOGS

*Lethal Dose:* With dogs as the experimental animals we studied the histologic changes in the organs after the dogs had been subjected to a lethal dose. In these animals the temperature was raised to from 110 to 112 degrees F. and kept there for thirty minutes. After the exposure the first animal was unable to stand, but lay on his side panting weakly. Most of the reflexes were absent. The dog was able to drink water but soon vomited it. The feces were bloody. The animal became rapidly weaker and died in four and one-half hours. Autopsy was performed immediately.

The autopsy report is as follows:

Blood and all tissues very cyanotic. *Heart:* Dark in color; pericardium and endocardium cloudy, subpericardial petechial hemorrhage, subendocardial ecchymotic hemorrhage very extensive in the left ventricle. Hemorrhage and edema of valve cusps. *Lungs:* Congested. Infarct in left lower lobe 4 mm. in diameter

and 1 mm. in thickness. Tracheal and bronchial mucosa very hyperemic. *Alimentary tract:* Hemorrhage into stomach, duodenum, jejunum, and upper ileum; mucosa of jejunum sloughing and very hemorrhagic; blood in the lumen. The lower ileum appeared normal. The colon was contracted firmly and the mucosa was hemorrhagic. *Liver:* Very dark in color but not enlarged. *Spleen:* Normal in size but small hemorrhages into the pulp varying from 2 mm. to 5 mm. in diameter. *Kidneys:* Medulla very dark; cortex striations very evident; mucosa of pelvis congested. *Adrenals:* Hemorrhages into the cortex.

A special study of the brain and cord of this animal was made by the Institute of Neurology (Dr. A. Weil). The report showed:

Brain sections show the blood vessels maximally dilated. There are small foci of extra-vascular hemorrhages. The ganglion cells of the cortex show the histologic changes which have been described as "Akute Schwellung." The Nissl bodies have disappeared and the cytoplasm presents itself in cresyl-violet sections as a fine granulated mass. The nucleus contains dark staining granules and the nucleolus stands out distinctly. The outlines of the cells are indistinct, and the cells are slightly swollen. The glia nuclei are well stained. In the spinal cord the changes are essentially the same as in the brain. The hemorrhagic foci are most pronounced in the posterior horns. The anterior horn cells present the picture of acute swelling, as in the brain.

A second dog died sixteen hours after the exposure, with essentially the same histologic changes. The gross changes in the organs closely paralleled death from heat prostration. (It was observed in heating these dogs that the temperature would rise gradually to 107 or 108 degrees F., but would then suddenly shoot up, indicating possibly a breakdown of the heat regulatory mechanism.)

*Sublethal Doses:* Sublethal doses are apparently without harmful effects, even if given daily. Dogs seem able to withstand a daily temperature rise of from 4 to 6 degrees F. In one series of experiments two dogs were radiated weekly, two dogs twice weekly, one dog daily (for two weeks), and

one dog daily for two months. The exposure was at 11 million cycles and was so regulated that the temperature of the animal was kept from 4 to 6 degrees F. above its normal for one hour.

No dog in this series exhibited any ill effects. There was a slight loss of weight at first in the animals subjected to the daily radiating, but no further loss. The weight remained constant at the lower level. The dog radiated daily for two months went into a tonic spasm at the fifteenth treatment when the rectal thermometer was inserted. The spasm lasted three minutes, the current being turned off. Again at the twenty-third, forty-second, and fifty-second exposures tonic spasms of short duration occurred, without the thermometer being inserted. Aside from these spasms the animal manifested no symptoms of ill effects from the exposure to the high frequency current. No other dog had tonic spasms. Seven months after his last treatment this dog was killed and his brain and cord removed for study. The following neurological report on this dog was submitted by Dr. T. T. Stone, of the Department of Neurology.

*Cord Dorsal 1:* Many ganglion cells are enlarged and rounder than normal. Nissl granules do not stain definitely, but appear like dusted particles. Nucleus is centrally placed in most of the cells. Many ganglion cells show neurophagia (satellite neuroglial cells surrounding the ganglion cell). No blood vessel abnormality. No evidence of fresh hemorrhages. No leptomeningeal reaction. Sensory gray matter is normal.

*Frontal Lobe:* Many ganglion cells do not take the nuclear stain. The Nissl granules are almost replaced by a powdery looking substance. Cells are of normal size. Architectonic arrangement of the cortex is retained. White matter shows a few distended blood vessels, with no changes in their walls. Leptomeninges show a moderate infiltration of large mononuclears, small round cells; an occasional polymorphonuclear leukocyte is seen in the leptomeninges. Van Gieson stains show evidence of red cells in the leptomeninges. Blood vessels are distended.

Hematoxylin-eosin sections show evidence

TABLE I

|            | Temp. degrees F. |       | Calcium<br>(mg. per 100 c.c.) |       | Chlorides<br>(mg. NaCl/100 c.c.) |       | CO <sub>2</sub> Combining<br>power of plasma |       | Total solids |       |
|------------|------------------|-------|-------------------------------|-------|----------------------------------|-------|--|-------|--------------|-------|
|            | Before           | After | Before                        | After | Before                           | After | Before                                       | After | Before       | After |
| Dog 1 (a). | 101.6            | 105.3 | 10.6                          | 11.0  | 477                              | 477   | 38   | 29    | 22.1         | 22.7  |
| Dog 1 (b). | 102.6            | 105.8 | 10.4                          | 11.2  | 468                              | 468   | 47   | 34    | 21.6         | 23.5  |
| Dog 2..... | 101.9            | 106.0 | 10.4                          | 10.4  | 484                              | 464   | 40   | 30    |              |       |
| Dog 3..... | 101.6            | 106.0 | 10.2                          | 11.2  | 473                              | 463   | 38   | 29    | 21.9         | 24.0  |

TABLE II

|             | Initial temp. | Final temp. | Change  |
|-------------|---------------|-------------|---------|
| Top.....    | 100.0° F.     | 103.0° F.   | 3.0° F. |
| Middle..... | 99.4          | 101.2       | 1.8     |
| Bottom..... | 100.6         | 102.1       | 1.5     |
| Top.....    | 99.0          | 102.6       | 3.6     |
| Middle..... | 99.8          | 102.3       | 2.5     |
| Bottom..... | 99.6          | 101.2       | 1.6     |

TABLE III

|        | Temperature |       | Calcium |       | Chlorides |       | CO <sub>2</sub> Combining<br>power |       | Total solids |       |
|--------|-------------|-------|---------|-------|-----------|-------|------------------------------------|-------|--------------|-------|
|        | Before      | After | Before  | After | Before    | After | Before                             | After | Before       | After |
| 1..... | 101.5       | 106.0 | 10.4    | 10.4  | 503       | 522   | 34.4                               | 27.7  | 19.7         | 21.0  |
| 2..... | 102.1       | 106.8 | 10.3    | 10.6  | 491       | 512   | 48.1                               | 37.6  |              |       |
| 3..... | 102.3       | 109.0 | 10.3    | 11.3  | 526       | 498   | 42.0                               | 20.0  | 17.1         | 21.6  |
| 4..... | 102.3       | 108.1 | 10.3    | 11.0  | 502       | 473   | 50.2                               | 33.0  |              |       |
| 5..... | 102.3       | 107.4 | 10.0    | 10.9  | 510       | 509   | 51.0                               | 23.0  |              |       |

of hemorrhage in the leptomeninges. There are many types of blood elements, leukocytes, lymphocytes, and plasma cells situated in the meningeal spaces.

*Parietal Lobe:* Blood vessels of the meninges are distended. Many cellular elements, as above, present in the leptomeningeal spaces. Hemorrhage is present here, also. The architectonic arrangement of the gray matter is not disturbed. Several motor cells (Betz) show a powdery appearance of the Nissl granules immediately around the nuclei, which are centrally placed.

*Temporal Lobe:* This area shows a marked distention of blood vessels of the leptomeninges, with many cellular elements around the spaces and in them. The ganglion cells are increased in size (seem swollen). There is no change in the Nissl bodies, or processes. Many of the cells in this section show marked increase in stainability of the Nissl granules. Blood vessels of the white matter are distended.

*Pons and Medulla:* Show distention of

blood vessels of meninges, with cellular elements as mentioned above. The cells are enlarged. No blood vessel or any other cellular change.

*Cerebellum:* The vessels around the periphery are distended. The Purkinje cells are enlarged. No other abnormal findings. In the hematoxylin-eosin sections the granular cell layer appears to be broken and the cells misplaced.

*Conclusion:* The brain showed an acute edema, confined primarily to the leptomeninges and the cortex. Microscopically there was definite evidence of distention of blood vessels, with extravasation of cellular elements in the leptomeninges. The ganglion cells of the brain and cord showed an acute reparable process primarily involving the Nissl bodies and affecting the size of the cell.

TABLE IV

|             | Initial temp.<br>(degrees F.) | ¼ hour | ½ hour | 1 hour | Change |  |
|-------------|-------------------------------|--------|--------|--------|--------|--|
| Vagina..... | 93.3                          | 93.3   | 95.3   | 100.4  | 7.1    |  |
| Liver.....  | 93.6                          | 95.6   | 97.6   | 103.4  | 9.8    |  |
| Spleen..... | 92.0                          | 95.2   | 97.5   | 103.4  | 11.4   |  |
| Gut.....    | 93.6                          | 95.5   | 97.5   | 102.6  | 9.0    |  |

|             | Initial temp.<br>(degrees F.) | 20 min. | 1 hour | 1½ hours | 2½ hours | Change |
|-------------|-------------------------------|---------|--------|----------|----------|--------|
| Rectum..... | 97.4                          | 98.9    | 103.3  | 106.5    | 110.0    | 12.6   |
| Kidney..... | 97.5                          | 99.1    | 102.8  | 105.7    | 108.6    | 11.1   |
| Femur.....  | 96.5                          | 98.4    | 102.6  | 105.8    | 109.0    | 12.5   |
| Brain.....  | 97.7                          | 99.3    | 103.3  | 106.4    | 109.2    | 11.5   |

TABLE V

|             | Initial temp.<br>(degrees F.) | ½ hour | 1 hour | 1½ hours | 2 hours |  |  |  |  |
|-------------|-------------------------------|--------|--------|----------|---------|--|--|--|--|
| Rectum..... | 96.4                          | 100.0  | 103.0  | 106.1    | 107.5   |  |  |  |  |
| Cord.....   | 94.4                          | 97.8   | 101.1  | 101.1    | 105.0   |  |  |  |  |
| Kidney..... | 96.2                          | 99.9   | 103.1  | 105.4    | 106.4   |  |  |  |  |
| Brain.....  | 95.5                          | 99.9   | 103.1  | 105.6    | 106.5   |  |  |  |  |

| The dog was allowed to cool down, then killed by ether intracardiac, then re-exposed. |                               |         |         |          |          |          |          |          |          |
|---|-------------------------------|---------|---------|----------|----------|----------|----------|----------|----------|
|   | Initial temp.<br>(degrees F.) | 20 min. | 45 min. | 1½ hours | 2¼ hours | 2¾ hours | 3¼ hours | 3¾ hours | 4¼ hours |
| Rectum.....   | 99.0                          | 97.4    | 97.0    | 98.8     | 101.0    | 102.7    | 105.3    | 106.9    | 109.0    |
| Cord.....   | 94.3                          | 91.2    | 90.8    | 91.8     | 94.5     | 94.6     | 96.1     | 97.8     | 99.3     |
| Kidney.....   | 94.4                          | 94.4    | 96.5    | 96.5     | 100.5    | 100.9    | 103.2    | 104.6    | 107.0    |
| Brain.....  | 93.4                          | ?       | ?       | 90.6     | 93.0     | 95.1     | 97.1     | 99.5     | 101.0    |

There was no evidence of irreparable damage to any part of the brain or cord.

The blood chemistry changes noted were essentially the same as those recorded in our determinations of the blood changes in dogs and men subjected to a diathermy current. Blood calcium remained unchanged or rose; chlorides remained unchanged, fell, or rose; alkali reserve decreased markedly (the animals became restless, and panted), and total solids increased about 10 per cent. The number of red and white cells increased also, undoubtedly due to the concentration of the blood. The blood chemistry determinations were made on the blood of the dog which was radiated weekly. Table III shows the results on the dog. At the fourth heating the

non-protein nitrogen and uric acid were also determined. The NPN went from 19.7 mg. per 100 c.c. to 23.4 and the uric acid changed from 1.42 to 1.91 mg. per 100 c.c. At the fifth treatment the NPN changed from 13.6 to 19.6, and the uric acid changed from 1.36 to 1.8.

From a comparison of these results with those resulting from a diathermy treatment it is seen that the changes are very similar. There appears to be a concentration of the blood. The chlorides respond irregularly, sometimes increasing, sometimes decreasing. A prolonged exposure to the vacuum tube oscillator where the rectal temperature rises above 110 degrees F. results in a death, in which the histologic changes observed

TABLE VI

|   | Initial temp.<br>(degrees F.) | 40 min. | 70 min. |
|---|-------------------------------|---------|---------|
| Rectum.....   | 98.4                          | 103.3   | 106.6   |
| Kidney.....   | 98.4                          | 104.1   | 106.0   |
| Brain.....  | 99.2                          | 105.2   | 107.6   |
| Spleen.....   | 97.7                          | 103.0   | 105.7   |
| Room.....   | 37.7 C.                       | 40.0 C. | 41.3 C. |
| The dog was allowed to cool down in the icebox, then killed and re-exposed. |                               |         |         |
|   | Initial temp.<br>(degrees F.) | 70 min. |         |
| Rectum.....   | 99.4                          | 103.6   |         |
| Kidney.....   | 99.6                          | 99.0    |         |
| Brain.....  | 99.0                          | 99.1    |         |
| Spleen.....   | 94.4                          | 96.1    |         |
| Room.....   | 39.0 C.                       | 42.0 C. |         |

closely resemble those resulting in death from heat prostration.

#### DO DIFFERENT ORGANS HEAT AT DIFFERENT RATES?

In the live anesthetized animal exposed to the high frequency current the different organs are heating up at approximately the same rate. The blood evidently serves as a very efficient distributing agent to maintain a uniform temperature. This is clearly shown by the following experiment. The viscera of a dog under barbital anesthesia are exposed, and the animal is placed in the high frequency field. Temperatures are taken at 15-minute intervals, the same thermometer being inserted to the same depth each time. Six such experiments were done in a constant temperature room, different combinations of organs being taken each time. Table IV shows the typical record of two dogs.

Conditions are different, however, in the dead animal. In death, there is no distributing medium of the generated heat, and different organs heat up at different rates. If heat were being generated by the radiations in both the live and dead dog at the same rate, one would expect the dead animal to heat up more quickly, since in the dead dog

heat loss is reduced to a minimum, while in the live dog the heat-regulating mechanism is allowed to operate unhampered.

To obtain information on this point we subjected four barbitalized dogs with viscera exposed to the high frequency current, taking records of the heating of the organs during life. The dog was then allowed to cool down to his initial temperature, killed, and the exposure repeated in the same constant temperature room. In these experiments the animal was so placed in the stock that the head was not in the electrostatic field. The results are striking, as shown by the typical results recorded in Table V.

It is clearly seen from the tabulation that in the dead animal the different organs do not heat up at the same rate. Not only do the organs not heat up as quickly in the dead animal as in the live one, but more than twice as much time is required to achieve the same temperature elevation. These results were confirmed in the other three experiments.

These observations naturally raised the question of why the live dogs heated up faster. The live dog is losing heat by respiration, the other heat losses being identical in both live and dead dog. The live dog is, of course, producing heat because of its metabolism, which does not occur in the

dead dog. Since it was impractical to measure the temperature of all the tissues in the dead dog simultaneously it was necessary to determine the caloric increase calorimetrically.

For this purpose a calorimeter was constructed large enough to accommodate a 7-kilo dog. The technic for estimating the caloric increase was the same as that given by Christie and Loomis (10). The specific heat of dogs was determined directly, as no figures were available for this value. To do this, ten dead dogs of known weight were placed in a constant temperature oven at 40 degrees C. for periods varying from ten to twenty-four hours. They were then immediately transferred to the calorimeter and the increase of temperature noted after equilibrium had been reached. From the observed temperature rise the specific heat was calculated. The average value obtained was 0.69, a figure in close agreement with the value secured by Christie and Loomis for mice.

In this next series of experiments the live dog was radiated for a fixed period of time, the temperatures recorded, the animal was allowed to cool down, then killed and re-exposed. In detail, when the rectal temperature had returned to normal the dog was immediately killed by intracardiac injection of chloroform and replaced in the field. The final temperature of the dead dog was estimated calorimetrically. In these experiments we found that the total elevation of temperature in dead dogs was considerably less than that found in live dogs. (We sought an explanation for this fact in the consideration that the live animal, while confined in the stock it is necessary to put him in in order to radiate him, is quite active, and this increased muscular activity leads to an increase in metabolism and to a higher temperature.) We thought also that the difference in temperature between the room and the dog resulted in a signifi-

cant radiation loss. To obviate both these objections the next series of animals were anesthetized with barbital, and the temperature of the room was raised to the initial temperature of the dog. The experiments on the animals with exposed viscera were repeated first. A typical result is shown in Table VI, one of four similar experiments.

The experiments on live dogs not operated upon under barbital anesthesia and on dead dogs in which the temperature change was estimated calorimetrically indicated that the radiation loss and increased activity of the confined animal are factors which contribute to the difference between the temperature rise observed in live and dead animals, but that they are not enough to account for this difference. In five animals investigated under these conditions the average temperature increase in the live anesthetized animal was 6.2 degrees F. for an average exposure of 38 minutes, while in the dead animals the average increase was 2.0 degrees F. (in one animal there was no change). It is possible that an overlooked calorimeter heat loss may be an important factor. Allowance for as much as a 25 per cent heat loss, which is extremely unlikely, does not bridge the gap. If heat is being generated by the radiations in both the live and dead dogs at the same rate, the elevation of temperature in live anesthetized dogs is considerably greater than that found in dead dogs. These results on dogs are contrary to the results on mice reported by Christie and Loomis (10). A possible explanation for the difference in these results may lie in the vast difference in mass radiated and in the length of exposure. Christie and Loomis used 20-gram mice and their average exposure was less than 10 minutes (in one case 29.8 minutes). The weight of our dogs was between 5 and 7 kilos, and the duration of exposure was never less than 38 minutes. Also, the basal metabolism of the live animal may play an



important rôle in its increased temperature rise, as it is known that for a 1 degree F. rise in temperature there is a 7.2 per cent increase in the basal metabolism. This energy is largely converted into heat and can contribute materially to the temperature elevation.

#### SUMMARY AND CONCLUSIONS

1. The biological effects of electromagnetic waves emitted by a vacuum tube oscillator have been studied at frequencies between 10,000 and 14,000 kilocycles per second.

2. The electrostatic field between the plates is not homogeneous, the heating effect varying in different parts of the field.

3. Sublethal doses given to rats daily for a month and to a dog daily for two months are without ill effects. The histologic changes are those found in animals subjected to hyperthermia induced by other means.

4. The lethal effect of these currents can be fully accounted for on the basis of heat production. The histologic changes observed closely parallel those in death from heat prostration.

5. The blood chemistry changes observed in dogs subjected to sublethal doses are very similar to the blood changes noted in the diathermy experiments: Calcium was unchanged or rose, chlorides increased or decreased, CO<sub>2</sub> combining power decreased markedly; total solids, non-protein nitrogen, and uric acid increased.

6. In the live anesthetized dog with viscera exposed, the different organs heat up at approximately the same rate, the blood serving as a very efficient distributing mechanism of the generated heat. In the dead dog the different organs heat up at different rates. Also, live anesthetized dogs heat up at a faster rate than dead dogs.

7. The effects produced on animals of

the diathermy current and the electromagnetic waves emitted by a vacuum tube oscillator can be fully explained on the basis of the heat generated by high frequency currents which are induced in them.

I wish to express my appreciation to Dr. A. C. Ivy for his kindly and stimulating help in the investigation of this problem.

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Radiation from Wireless Valves. H. M. S. Turner. *Lancet*, Dec. 27, 1930, CCXIX, 1437.

High-power wireless valves are provided with a water-jacket or a highly refractory substance may be used instead of glass, with air-cooling. In certain valves fused silica is used for this purpose. Valves of this type were tested by exposing X-ray films to the emanations from the tubes. Each film was enclosed in its light-proof container and one film, in its container, was enclosed in an envelope made from thick sheet-lead, on the front of which a cross had been cut out after the manner of a stencil. In front of the others, letters cut from sheet-lead were closely applied. The exposure was two hours, with the films at a distance of eight inches from the valve tubes. The voltage uniformly throughout the exposure was 9,000 and the milliamperemeter reading was 160 to 170. All the films, when developed, showed the effect of the radiation, and reproductions of these radiograms are shown in the article. It is suggested that an individual working constantly in rather close proximity to the tubes might

possibly receive enough radiation to get the so-called cumulative effect, even if small. No history of erythema or any other indication of effect on the attendants about these tubes could be found, but for obvious reasons no leading questions were asked. It is suggested that perfect protection be obtained by screening the valves with metal or lead glass screens of suitable proportions. The penetrating power of these radiations was not determined, as no means were at hand for measuring it, and no estimate of the quantity by any of the standard units used in the work with the roentgen ray was made. The author desired to record the fact that radiograms can be taken by the agency of such valves.

H. J. ULLMANN, M.D.

X-rays in Stars. A. S. Eddington. *Strahlentherapie*, 1930, XXXVII, 1.

This is the German translation of a well written lecture which English readers interested in the subject may find in the *British Journal of Radiology*, March, 1930, III, 99.

ERNST A. POHLE, M.D., Ph.D.

# THE OBLIQUE PROJECTION IN EXAMINATION OF THE LUMBAR SPINE<sup>1</sup>

By M. J. HUBENY, M.D., CHICAGO, ILLINOIS

THE prime object in making a diagnosis is to be able to select the proper remedial measures, to alleviate or cure a disease, or to prevent unnecessary detrimental interferences. However, since the enactment of legislation under which the employer is obliged to compensate an employee for injuries sustained during the performance of his duties, a new condition has arisen requiring proper adjudication to all con-

Subjective symptoms can never be completely disputed; however, the precise methods now possible in scientific medicine re-

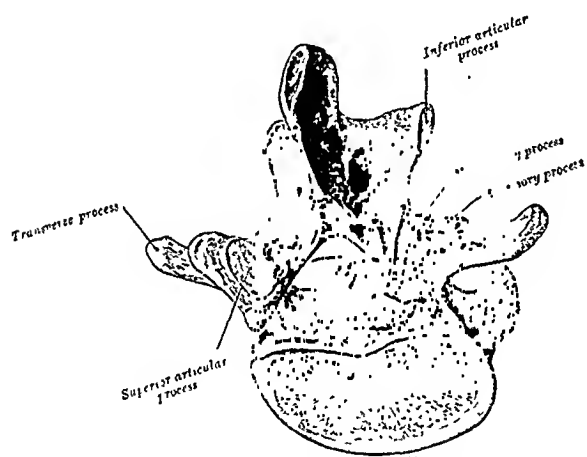


Fig. 1. Typical lumbar vertebra. Note direction of articular facets.

cerned; certainly, this means of compensation is a proper responsibility to offset more or less disability, either permanent or temporary, with the consequent inability to enjoy the fruits of a gainful occupation.

As in most instances in which a monetary gain is possible, malingering immediately becomes a common practice, especially successful if collusion exists among a dishonest patient, a dishonest lawyer, and a dishonest doctor; hence it becomes apparent that great care must be exercised to circumvent such practices.

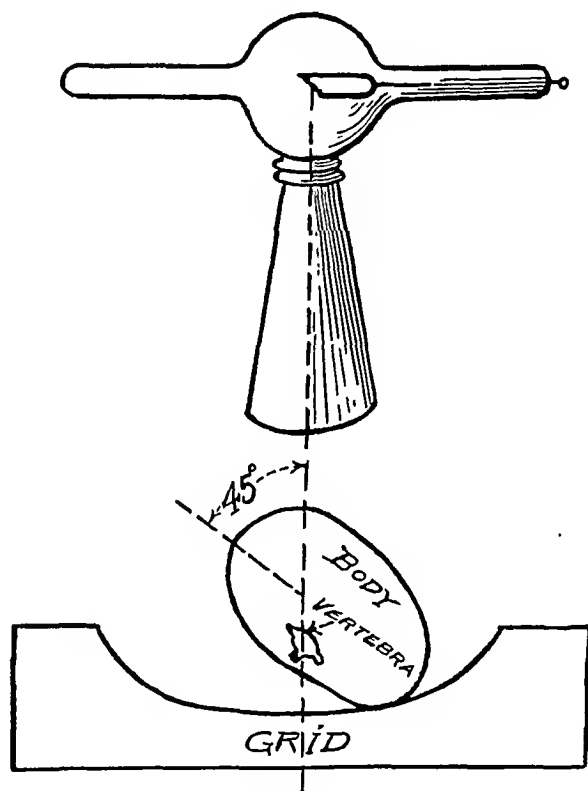


Fig. 2. Schematic drawing showing relationship of tube, spine, and film.

duce many of these symptoms to tangible entities because they must be reconciled with sound thinking and new facts.

In injuries, the skeletal system is frequently involved, and, by means of a proper and thorough roentgen examination, certain possibilities are definitely established, either positively or negatively.

The roentgenologist should be free to choose all the angles necessary, particularly when the spinal column is under investigation. It is constructed of a number of

<sup>1</sup>Read before the Radiological Society of North America at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1-5, 1930.

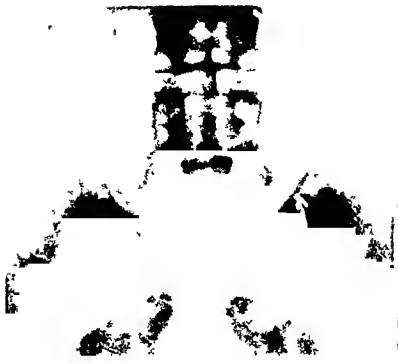


Fig. 3. Figures 3, 4, 5, and 6 are of the same patient. Above (Fig. 3) is the antero-posterior projection. The articular facets between the fifth lumbar vertebra and the sacrum are not satisfactorily seen (cf. Figs. 4 and 5). Does the left fifth transverse process make contact with the ilium (cf. Fig. 6)? No, it does not.



Fig. 4. Compare facets marked "1" with facets marked "2" on Figure 5. Note arthritic changes of the latter.



Fig. 5.

provided for by the interposition of the intervertebral discs between the bodies of the vertebræ, which act as buffers in counteracting the effects of violent jars or shocks.

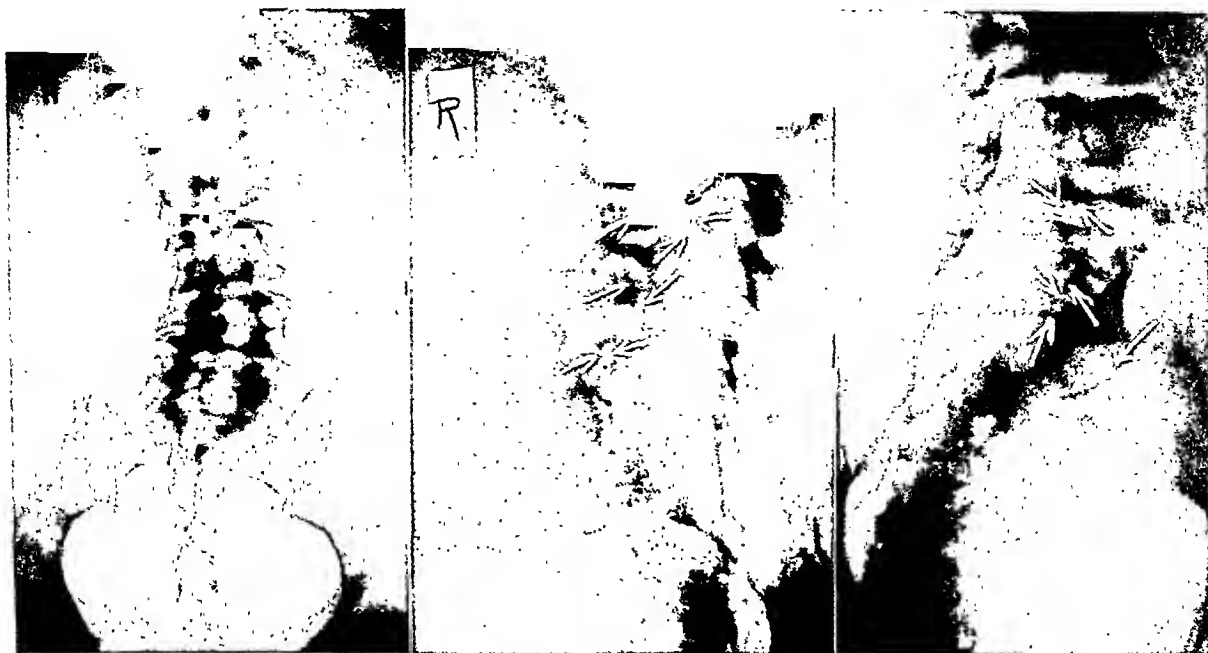
Fracture dislocation of the vertebral column may be caused by direct or indirect violence or by a combination of the two. The fractures from indirect violence are the more common and here the bodies of the vertebræ are compressed, while the arches are torn asunder; in fractures from direct violence the arches are compressed and the bodies of the vertebræ are separated from each other. It will, therefore, be seen that in both classes of injury the spinal cord is the part least likely to be injured and may escape damage even when there has been

pieces, securely connected together and having only a slight degree of movement between any two individual pieces, though permitting of a very considerable range of movement as a whole, allowing a sufficient mobility with a minimum diminution of strength.

The main joints of which the spine is composed, together with the varied movements to which it is subjected, render it liable to sprains, which may complicate other injuries or may exist alone, but so closely are the individual vertebræ articulated that these sprains are seldom severe and an amount of violence sufficiently great to produce tearing of the ligaments would tend to cause a fracture or dislocation. The further safety of the column and its freedom from liability to injury are provided for by its arrangement in curves instead of one straight line. For it is an elastic column and must first bend before it breaks. Under these circumstances, being made up of three curves, it represents three columns, and greater force is required to produce bending of a short column than of a longer one that is equal to it in breadth and material. Again, the safety of the column is



Fig. 6. The fifth left transverse process does not contact with the ilium (cf. Fig. 3).



Figs. 7, 8, and 9. These three films are of the same patient. Essential diagnosis was "preternatural mobility of the fourth and fifth lumbar bodies due to faulty development of the right articular facets." The oblique projections show pretty good mechanical arrangement and development of these facets. A bone transplant was advised, but the patient objected. After the removal of a highly adherent appendix, the predominating symptom of intense right lumbar backache disappeared.

considerable damage to the bony framework.

The parts of the vertebral column most liable to be injured are, first, the thoracolumbar region; second, the cervico-thoracic region; third, the atlanto-axial region.

#### ANGLES FOR STUDY

This paper has to deal with a technic

especially adapted for a more detailed study of the bodies of the lower dorsal vertebrae, the lumbar spine, and the upper sacral segments.

It is not intended to displace the usual angles, namely, flat or stereoscopic antero-posterior projections and the lateral projections, but to amplify them; as a matter of fact, a flat antero-posterior plus the two



Fig. 10.

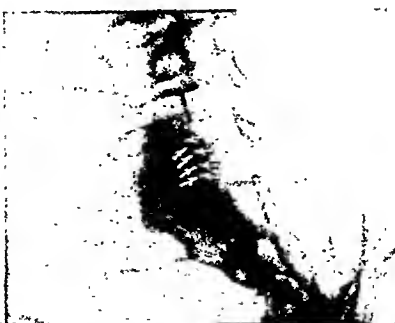


Fig. 11.



Fig. 12.

Figs. 10, 11, and 12. These three films are of the same patient. Asymmetrical pelvis. The adjoining left facets of the fifth lumbar vertebra and sacrum are visible in Figure 10 and also in Figure 12, while the corresponding right facets do not show in Figure 10, but do show in Figure 11.



Figs 13, 14, 15, and 16 These four films are of the same patient. Sacralized fifth lumbar vertebra. The arrows in Figure 13 (*upper left*) call attention to what was considered a possible over-riding.

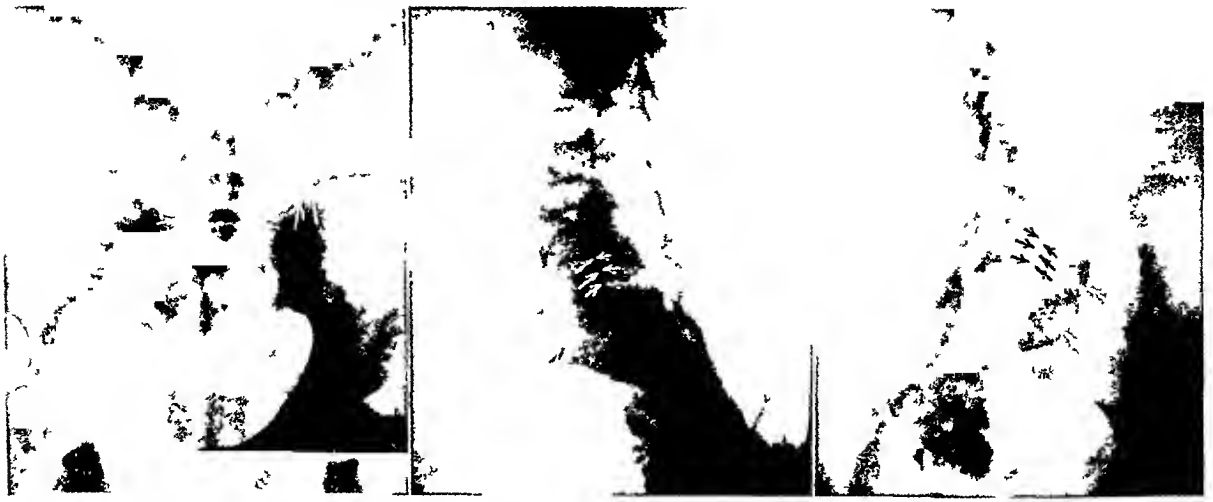
Fig 14 (*upper right*) The central beam is lower than in the case of Figure 13, also directed cephalicward. This is a more satisfactory film than the one shown in Figure 13, but still unsatisfactory (cf Figs 15 and 16).

Figs 15 and 16 (*lower left and right, respectively*) These films show no over-riding. They do show the articular facets, a horizontal promontory, and irregularity of the adjoining surfaces of the fifth lumbar body and sacrum.

oblique projections to be described are the ones of choice, to be used routinely.

The articular facets, the relation of the transverse processes of the fifth lumbar vertebra to the ilia, and the apposition of the fifth lumbar vertebra to the sacrum are more definitely outlined, also many times

the spinous processes of the fourth and fifth lumbar vertebrae are depicted with greater clarity. It is surprising to get bone detail and architecture far surpassing the complete lateral projection. The reason is quite obvious: first, the part under examination is closer to the film; second, the



Figs 17, 18, and 19 These three films are of the same patient. Calcification of the left ilio-lumbar ligament. The facets of the sacrum and the adjoining ones of the fifth lumbar vertebra are not satisfactorily demonstrable. In Figure 18 (*center*) note the clarity of the facets, also the relationship of the fifth lumbar body to the sacrum.

thickness is considerably lessened in the oblique position.

The lateral projection is unsatisfactory in tracing the articular facets; since the superior facets tend to face inward and backward and the inferior facets forward and outward it becomes apparent that placing the body at an angle is a necessity.

#### TECHNIC

Use large films for a general survey only; for detail, smaller films are to be used. Naturally, double screens, duplitized films, and a Potter-Bucky diaphragm are necessary. The technical factors are left to the discretion of the roentgenologist.

The patient lies partly on the right side so that the transverse line is approximately forty-five degrees to the horizontal plane

(namely, the top of the table). The spinous processes should be in the mid-line of the diaphragm and will be elevated a short distance therefrom, because the patient is tilted with the left side of the body away from the film. The central beam is perpendicular to the film, and directed over the particular area under suspicion.

The mate to this film is taken next, repeating this process with the exception that the patient lies on the left side. In this way the two sides are portrayed for comparison, one showing the details of the articular facets, neural arches, etc., of one side, while the mate depicts those of the other side.

This examination is especially useful in detecting pathologic conditions of the facets and is far superior to other methods in detecting fractures of the bodies, dislocations, and spondylolisthetic involvements.

## SYMPOSIUM ON PHYSICAL THERAPY

INTRODUCTION BY ERNST A. POHLE, M.D., PH.D., PROFESSOR OF RADIOLOGY  
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THE science of radiology embraces the application of the entire electromagnetic spectrum in clinical work. While many of you limit yourselves in your chosen field to the use of roentgen rays and radium for diagnosis and therapy, there are also many, and I believe it is a steadily growing number, who have added other parts of the spectrum, for instance, ultra-violet radiation and other closely related fields, such as high frequency currents, to their therapeutic armamentarium. This development, I believe, is a desirable one, and a few examples may illustrate my statement. Most striking in this respect is the successful combination of electrocoagulation and X-rays or radium in the removal of malignant tumors. There is also the use of ultra-violet radiation in clearing up secondary infection in post-operative cases, or for general body exposure in connection

with local roentgen or radium treatment of patients with lessened resistance.

Similar considerations have induced your President to place a Symposium on Physical Therapy on the program. Although the three papers in this symposium will cover some phases of physical therapy which are not so closely related to the daily work of the radiologist, I trust that they will arouse your interest sufficiently so that you too will join in helping to promote the scientific development of physical therapy. In addition to these papers, there will be practical demonstrations showing the different types of apparatus available at present for the production of ultra-violet rays, high frequency currents for diathermy, desiccation and coagulation, including the endotherm knife, and also some measuring instruments designed for clinical use.

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# EDUCATIONAL PROBLEMS IN PHYSICAL THERAPY<sup>1</sup>

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THE medical profession is now employing physical therapeutic methods to a greater extent than in the past, because scientific investigation and application have shown that they have a definite place in medical practice. Physicians and physicists interested in the various branches of this field are frequently adding more accurate information. The difficulty which prevents more rapid dissemination of the present knowledge is the lack of sufficient opportunity for the physician and his assistants to gain adequate instruction.

The limits of the field of physical therapy are not well defined, so that many procedures are instituted under this name which are really not a part of it. It is also true that there are many methods employed under the name of physical therapy which are not physiologically sound. For this reason it is clear that, until fancies are separated from facts and the practice is placed upon a more rational basis, the inquiring physician may often look askance at some of the procedures.

The further advancement of physical therapy will depend to a great extent upon the value which can be derived from these methods. When more experimental and clinical evidence has been found which will point to the correct use and define the limitations of the measures, the profession will manifest a more active interest and their efforts will be much more intelligently directed.

It is, therefore, the present situation in regard to instruction in physical therapy which will be considered in this paper.

There are three groups of individuals who are particularly interested in this work: physicians, undergraduate medical

students, and technicians. Because of the different points of view and interests of these groups each must be considered separately. The first group is composed of physicians who desire to practise physical therapy, those who wish to use the methods in conjunction with their general practice or specialty, and those who refer their cases for treatment.

For the physician who expects to limit his practice to physical therapy, or roentgenology and physical therapy, there are very few short and intensive courses that are worth while. Usually, the physician must visit several different hospitals and pick up in a desultory fashion whatever appears of value. Because of this lack of educational facilities for the physician who specializes in physical therapy, the caliber of his work is frequently not so high as that found in other special medical fields. It is necessary, therefore, that teaching institutions equip themselves for more complete instruction in this type of work.

The physician who would like to add one or more physical therapeutic methods to his practice finds in teaching institutions little opportunity for organized work such as he desires. Provision for such work is one of the most outstanding needs at the present time. To meet this demand, one institution through its post-graduate department accepts physicians who wish to study and observe special phases of the subject for short lengths of time. A small fee is charged, and the responsibility of assisting the visiting physician in his study and observation is placed upon the physical therapist. Although this arrangement is not entirely satisfactory, much valuable information may be imparted. There is no doubt but that this does place the visiting physician in a different category from that

<sup>1</sup>Read before the Radiological Society of North America at the Sixteenth Annual Meeting, at Los Angeles, December 1-5, 1930.

of one who makes a few casual visits to such a department.

This lack of educational facilities in teaching institutions explains in part why many physicians secure their information on physical therapy from courses fostered by commercial interests, and why more progress has not been made in developing the methods among practitioners.

The Council on Physical Therapy of the American Medical Association (1) and some of the physical therapy societies (2) have taken the first steps for the practical education of the physician. The presentation of lectures and clinics to the county medical societies and meetings of the associations, which are given as preliminary instruction in the subject, marks progress in the advancement of this important branch of therapeutics.

The physician who does not himself wish to use physical therapeutics, but prefers to send his patients to specialists or clinics doing this type of work, is also more interested than formerly. Evidence of this is seen in the growth of physical therapy clinics and hospital departments during the last five years. Frequently the referring physician has not had the opportunity to acquaint himself with the possibilities of physical therapeutic practice. He often looks for results which are not possible from any type of therapy. If a better opportunity for gaining information were provided, such a situation would be less frequent. To overcome such difficulties a consultation is often helpful in order that the physical therapist may discuss the possibilities of treatment with the referring physician, and at the same time acquaint himself more fully with the problems confronting the physician. It frequently happens, however, that the physical therapist becomes so engrossed with the details of his own work that he loses his perspective and exaggerates the importance of the measures in which he is interested.

It has been observed that an opportunity for education of both the staff and the physical therapist will be presented if the latter will participate with the staff on visits to routine medical and surgical cases. This affords an opportunity for an interchange of ideas and tends to more hearty co-operation on the part of both groups.

The field of physical therapy has developed so rapidly that much more attention has been paid to the instruction of the undergraduate medical student than of the practising physician. Four years ago the announcements of medical schools and hospitals (3) indicated that only eighteen medical schools were providing courses in physical therapy, although nineteen others were giving time to the work in other courses. To-day there are only a few that do not make some provision for the instruction of their students in physical therapeutic measures. Not only is the number of medical schools teaching physical therapy increasing, but the courses are being extended and the quality of the instruction is being improved.

The teacher of physical therapy is not aided by the extensive background of experience and investigation which has been accumulated in other fields of therapeutics. Because of this condition it is most important that he select carefully the material which he places before his students. This must be scientific, compatible with other forms of medical practice, and of practical value. Instructors must also be continually searching for important and new investigations, which are constantly being reported, so that the present inadequate evidence relating to some of the physical therapeutic agents may be amplified. Most medical courses do not permit the expenditure of much time on physical therapy; therefore, the instruction is not commensurate with that given to subjects of equal importance, nor sufficient to ground the student in the fundamentals.

The material to be given the student and the location of the course in the curriculum are questions upon which few teachers of physical therapy seem to agree. Many schools have simply added physical therapeutics to the general course of therapy, while others furnish an optional course in the clinical years. Some few have taken the step of introducing a required course, with further work as an elective. One of the difficulties found when physical therapeutic methods are mixed with others or when the course is placed in the last year is that the students are not interested in the physics and applied physiology, but wish to learn only the technical procedures. It is obvious that without first learning the fundamentals the technical knowledge will be of little value.

Possibly the best arrangement at the present time is a short required course in the sophomore year and further electives in the clinical years (4). A part of the foundation for physical therapy can be laid in the pre-medical school years. Instruction in the physics of radiation, electricity, and the general properties of matter should be presented in such a way as to be more applicable to the future needs of the student of medicine. A short course during the sophomore medical year is very desirable. In this instruction period the physical principles as they apply to physical therapeutics should be reviewed and followed by studies of the physiological action of the agents. Courses in the clinical years should likewise be provided. It is advisable at this time to teach the practical application, with most emphasis placed upon the therapeutic action and indications for treatment. Instruction in technic should also be given to the students in groups of four or six, but it should always be secondary to the study of clinical indications and effects. The object of such courses is not to train physicians to be technicians, but to give

them a knowledge of the therapeutic principles.

Because of the amount of time required for the purely technical work the actual application of physical therapeutic measures cannot be carried out on a large scale by the physician without adequately trained assistants. The training of competent technicians is, therefore, a matter of considerable importance (5). Many institutions have started courses for the training of physical therapy technicians, but few have the facilities for providing a complete and well rounded training. It is only in teaching institutions where instruction in the basic sciences can be combined with practical application that technicians can receive the most satisfactory training.

The educational standards for technicians set forth by the American Medical Association (1) and the American Physiotherapy Association require that the students have special preliminary training in the fields of nursing, physical education, or some allied activity. A number of the larger teaching institutions will admit only students who have successfully completed courses of nursing or physical education in recognized schools.

The course itself includes instruction in anatomy, physiology, pathology, and physics, as well as the technic of physical therapeutic application. A total of twelve hundred theory and practice hours is suggested, more than half of which are to be devoted to the theoretical work. At the present time only a few schools are able to meet these requirements, but it is encouraging to note that others are expanding their curricula so that their courses provide better training.

Thorough education of technicians will provide trained assistants in hospital departments and large clinics, but it will not supply the type of assistants required by most physicians in private practice. They should be able to secure an assistant trained

in the various types of laboratory work as well as in the technic of physical therapeutic methods. Since it is the practising physician who will do much of the physical therapy in the future, the training of this type should not be neglected.

#### SUMMARY

In this paper three lines of educational activity have been discussed: The first deals with providing educational facilities for the physician and is most pressing; the second, which concerns education of undergraduate medical students, indicates that progress is being made; the third, relating to activities in the field of technical training for assistants, points out that the present methods are meeting the needs of only a small part of the profession.

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# BIOPHYSICAL PRINCIPLES OF PHYSICAL THERAPY<sup>1</sup>

By K. W. STENSTROM, PH.D., MINNEAPOLIS, MINNESOTA  
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PHYSICAL therapy utilizes the transfer of energy in one form or another to the human body in order to influence a pathologic condition either locally or generally. Such a transfer of energy takes place all the time under normal conditions and, if increased beyond certain limits, leads to the death of the individual. This refers to heat as well as to radiation and electric currents. It is, therefore, evident at once that whether a beneficial or detrimental effect is produced depends upon the quantity of energy applied as well as upon the quality. Unless the energy is measured in a proper way and unless we have found out how much is needed to accomplish the desired effect in the individual, we cannot expect to obtain good results. We have, then, from the outset two problems, one purely physical and the other one biological. Neither one of these should be neglected. It seems, therefore, that an intimate co-operation between physicists and physicians should lead to the best results.

From the physical point of view the agents used can be analyzed in a satisfactory way and the quality as well as the quantity of the energy applied may be determined. To find out in detail just what effect the treatment has on the biological object is, however, impossible. The best we can do is to study certain physical or chemical components of the animal or human being or certain functions and note to what extent they change with the treatments. So many more or less uncontrollable factors enter in, however, that even those simple changes we observe may be incidental instead of direct consequences of the applied energy. A statistical method is usually needed to give us information about

the effects. It is this complicated biological aspect which sometimes makes the physician neglect the physical measurements or consider them unnecessarily accurate. The physicist, on the other hand, may sometimes go too far and prepare to make elaborate determinations where less accurate measurements would facilitate the biological experiment and lead to satisfactory conclusions. However, as a rule, we can state that detailed quantitative knowledge of the agent one uses is necessary for experimental work as well as for proper routine treatments. The forms of energy we shall consider here are electric currents, electromagnetic radiation, and heat.

## RADIATION

When radiation is used for treatments it is important to know what kind of rays are present in the beam. The most useful theory at the present time is that the rays consist of electromagnetic waves moving with great velocity. The wave length defines the radiation. Any electromagnetic radiation can be spread out into a spectrum and each part of the spectrum is represented by certain wave lengths. The only satisfactory way of defining the radiation is by its spectral distribution. The first fundamental established fact which should be remembered is that all electromagnetic radiation is transported with the same velocity through a vacuum. This velocity amounts to about  $3 \times 10^{10}$  cm. per second, a constant which usually is designated by the letter  $c$  ( $c = 2.9986 \times 10^{10}$  cm./sec.). The very simple relation  $c = \nu \lambda$  states that the velocity is equal to the wave length ( $\lambda$ ) times the frequency  $\nu$ . It, therefore, does not matter whether the radiation is defined by the wave length or by the frequency, as the

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value of one of these quantities can be easily calculated when the other one is known. The spectrum has been divided up into certain large ranges. Thus rays from radium occupy the region 0.005 to about 0.5 Ångström unit (Å.U.)<sup>2</sup>; roentgen rays used in therapy 0.06 to 5 Å.U.; roentgen rays and ultra-violet radiation too easily stopped by air to be considered for treatments 5 to 2,000 Å.U. Ordinary ultra-violet radiation 2,000–4,000 Å.U. (200–400 mμ); visible radiation 400–800 mμ; infra-red radiation 800–100,000 mμ; radio and wireless rays 0.1 mm.–50,000 meter γ-rays and roentgen rays are usually considered separately and adequately and will not be taken up in detail here. Ordinary ultra-violet and infra-red rays belong definitely to the physical therapy field and will be referred to in the following discussion.

*Absorption and Measurements.*—The rays assert an effect only when all or part of them are absorbed; that means, when some of the radiant energy is changed into some other form of energy. When visible radiation strikes a black surface most of the energy is transformed into heat. The infra-red rays are changed into heat with especial ease, and that is why they sometimes have been called "heat rays." This is, however, a very poor nomenclature, as radiation is one form of energy and heat another form.

A very satisfactory way to measure the intensity of radiation is to let a narrow beam strike a blackened metal surface and thus be transformed into heat. The amount of heat produced can then be measured in one way or another. If the blackened surface is at the junction of a thermocouple, an electric potential is set up and an electric current may be produced which can be measured by means of a sensitive galvanometer. If the rays have been spread out to a spectrum by means of a spectroscope be-

fore they strike the thermocouple, the intensity can be determined for each wave length. This method of measuring radiation can be used throughout the whole range referred to here. Rays of short wave length (ultra-violet and part of the visible) liberate electrons when they strike a metal surface. This property can be utilized to measure them by means of a photo-electric cell and a galvanometer, a rather simple method which is used to a great extent. It must be kept in mind, however, that the efficiency varies with the wave length and the photo-electric cell must be calibrated for the part of the spectrum for which it is going to be used. Special care must be taken because this type of instrument may change its sensitivity with time, and recalibrations are, therefore, required. The cadmium photo-electric cell can be employed without the use of a spectroscope to measure the intensity of the radiation in the ultra-violet of the region effective in producing an erythema as it has a selective sensitivity in this region. The cell must, of course, be standardized and should be rechecked regularly (1). The color change produced by ultra-violet radiation in a methylene blue solution has also been recommended for determination of dosage. It must be remembered that a slight change in pH as well as the presence of a small impurity may have a pronounced effect on such a color change. Other chemical reactions may be influenced in a similar way. Special precaution must, therefore, be exercised if they are used to measure dosage.

The primary effect of the radiation on tissues can take place only where the rays are absorbed. Careful measurements have led to the conclusion that so-called far infra-red rays longer than about 1,400 (2) mμ are absorbed intensely by water and that they are practically completely absorbed by a few millimeters of tissues. Near infra-red and visible radiation are more penetrating, the maximum penetrabil-

<sup>21</sup> 1 cm. = 10 mm. = 10,000 μ = 10,000,000 mμ = 100,000,000 Å.U. = 10<sup>8</sup> Å.U.

ity being around 1,200 m $\mu$ . Measurements have been made of the penetration through the cheek of a full grown person. According to Danforth, 20 per cent penetrates the cheek at this wave length (3). The tissues are quite opaque to ultra-violet radiation, and, on the whole, the more so the shorter the wave length. Between 240 and 310 m $\mu$  they are so easily absorbed that practically nothing passes through the skin. The direct action of this important zone, therefore, undoubtedly is limited to the skin itself unless the underlying tissues are denuded. Some recent biological experiments by Miescher (4) indicate that a thickness of 9 $\mu$  of stratum corneum reduces the intensity of this radiation to one-half, and one of 90 $\mu$  to about 0.1 per cent. It is interesting, too, that the amino-acids with a phenol ring, and, consequently, most proteins, have an absorption band around 280 m $\mu$ , and that hemoglobin has several absorption bands in the visible region as well as an intense one in the region around 400 m $\mu$ .

*Action.*—It is well known that infra-red and visible radiation heat the tissues. Therefore a great portion of these radiations must be transformed directly into heat: whether they have any other effect has not been definitely determined as yet. As they are fairly penetrating, they carry the heat into the tissues to a certain extent and this may be of great importance, as, *e.g.*, pointed out by Sonne (5) (destruction of toxins, etc.). The shorter rays may also be transformed into heat to a certain extent, but they evidently also have other actions. The photo-electric effect undoubtedly leads to chemical changes. This is particularly evident in the region of from 240 to 310 m $\mu$ , which produces skin erythema, activates ergosterol, etc. The pigmentation of the skin is a later effect of this radiation, but may, according to Uhlmann (6), also be produced by waves around 313 and 366 m $\mu$ . As is noticed from this, erythema and pigmentation are not as closely correlated as

was usually assumed, and the latter is not just simply a consequence of the former. It is well known that exposure to erythema-producing ultra-violet rays makes the skin less sensitive to subsequent exposures, but it has been under discussion how this protection is brought about. Undoubtedly, the pigmentation contributes to a certain extent to this protection, but Miescher (4) has on the basis of a series of convincing experiments concluded that the main factor is the thickening of the stratum corneum. This seems very plausible if it is true that 9 $\mu$  of the layer absorbs 50 per cent of this type of radiation. If, *e.g.*, the stratum corneum is thickened from 10 $\mu$  to 30 $\mu$  (as he found in one experiment), about four times as much exposure would be required to produce the same reaction as before.

Insofar as light therapy is concerned it is evident that it can be very effective. It is also clear from the previous discussion that the action depends upon the spectral distribution of the radiation used. Both qualitative and quantitative measurements are required in order that the best results may be obtained. A great amount of research is needed in order to determine just which type of radiation is best for a certain condition. The extreme difficulty in determining the "dose" given an individual during a treatment as a consequence of the variation in thickness of the stratum corneum should never be lost sight of.

## ELECTRIC CURRENTS

Different types of electric currents have different effects upon the human body: the first requirement, then, is to differentiate between the various types. An electric current means movement of very minute electrically charged particles. In a metallic conductor the current is carried by negative electrons; in an electrolyte by an equal number of positive and negative ions. The current can be either direct or alternating. The

particles which transport the current do not change the direction of movement in a direct current. In an electrolyte, *e.g.*, the positive ions are moving in one, and the negative ions in the opposite, direction continuously. In an alternating current the direction of the movement changes and the number of times per second the particles return to their first direction is referred to as the frequency of the current.

If the current does not change its intensity with time it is referred to as a constant direct current. The intensity of such a current is determined by the resistance of the conductor and the potential difference between the ends of this conductor. The practical unit for the resistance is the ohm ( $\Omega$ ), for the potential difference the volt (V), and for the current the ampere (A).

If these units are used, the simple relation holds  $A = \frac{V}{\Omega}$  (Ohm's law). If a current of

one ampere passes through a metallic conductor, it means that  $6.281 \times 10^{18}$  electrons pass through the cross-section per second. Due to the resistance some of the electricity is transformed into heat and the amount thus transformed is equal to  $0.24 A^2 \Omega$  calories per second (Joule's law). Slight fluctuations in the current do not affect these relations considerably if average values are taken. The simplest form of alternating current is the so-called sinusoidal, which changes intensity continuously and smoothly up to a maximum and down to zero again, then below zero to a minimum value, and then back to zero, and so on. One such complete change, as described, is called one cycle. Currents with almost any number of cycles per second, of any frequency, can be made. The most common is the 60-cycle current, available in most cities. The average value of this current at a certain cross-section is zero, as just as much current passes in one direction as in the opposite direction, and it, therefore,

cannot be measured with a direct current meter. The effect is, however, proportional to the square of the current, and the square is, of course, always positive. The effective current is equal to the square root of the average of the square of the intensity. The A.C. is influenced by reactance and capacity as well as by resistance. These new factors are of greater importance the higher is the frequency of the current. The heat produced is, however, still  $A^2 \Omega$ , if  $\Omega$  is taken as the "effective" resistance through which the current A passes.

The faradic current consists of sudden impulses which last for a very short time, with longer intervals in between. The impulses alternate directions and are usually more abrupt in one direction than in the other.

*Current through Tissues.*—An electric current passes through the body in a way similar to that in which it goes through corresponding types of inanimate conductors. From a physico-chemical point of view, tissues can be regarded as made up of membranes and fluids. The membranes are very poor conductors, while the fluids are good conductors of the electrolyte type. The electricity is, therefore, transported by ions. If two resistances are in series, the same current passes through both; if they are connected in parallel, the current is divided between them in such a way that  $\frac{A_1}{A_2} = \frac{\Omega_2}{\Omega_1}$ . The greater portion of the current passes through the smaller resistance, but some goes through the higher resistance. If the two electrodes are applied to the skin at different parts of the body, the current has to pass both through the skin and the underlying tissues, these structures being in series. Most of the current passes straight through the soft tissues because the resistance there is low; some spreads out sideways, but as this portion of the current has a longer pathway, the resistance is



the lungs is prevented. Dry hot air baths are, of course, very effective in producing perspiration, but, due to intense evaporation, the temperature of the body is kept much below the temperature of the air. Hyperpyrexia produced by means of external physical sources is sometimes referred to as "artificial fever." Would it not be better to reserve the name "fever" for diseases in which the temperature-regulating mechanism is disturbed in such a way that the temperature equilibrium is brought above 37° centigrade? Hyperpyrexia has long been used for treatments of certain diseases, but its effectiveness has not been generally accepted. New interest in it has been awakened with the introduction of modern devices which permit more perfect regulation of the temperature. Hyperpyrexia is, of course, injurious to a certain extent to the normal tissues and their functions, but it evidently is more harmful to certain bacteria and certain bacterial toxins as well as to malignant tissues. Therefore, the possibility exists that it may be effective in certain diseases if used properly. Necrosis of the tissues may result if the increased temperature is kept up for any length of time. Some experiments by N. Westermarck (10) have shown that tissue necrosis can be produced in rats if the local temperature is kept at 44° C. (111.2° F.) for about three hours. The knowledge of the physiological, biochemical, and hematological effect of hyperpyrexia in contradistinction to fever is essential for further advance in this field. These effects are being

studied now at several laboratories and some interesting findings have already been brought out. The effect on the blood of a temperature increase up to 106° and lasting for from three to five hours is not nearly so pronounced as that of fever. The pulse rate and the diastolic blood pressure are definitely increased, and the metabolism also seems to be increased. Such a treatment causes a loss of several pounds of fluid in form of perspiration, evidently releasing a great amount of bound water into free water and removing it through the skin. It is possible that the investigations of this type finally will lead us to definite conclusions concerning the effectiveness of heat treatments, as well as concerning the proper temperature and time to use them.

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# CLINICAL APPLICATIONS OF ULTRA-VIOLET RAYS<sup>1</sup>

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A HOSPITAL to be recognized as modern must be so equipped that the sick may benefit by the latest discoveries in medical science. Among the most important advances in modern therapeutics is the proper use of physical agents. The physical agents of the greatest use to the general practitioner are heat, light, water, massage, and exercise. In the use of these agents by the general practitioner it is important that they be on definite prescription, as are drugs, and that they be employed for long periods daily, for which some arrangements must be made for their use at home. This has been considered elsewhere by one of us (22), and in this short article it is desired to consider one physical agent used today in most hospitals, namely, ultra-violet radiation.

The lack of standardized methods of measurement of dosage, of careful records, and the follow-up of cases in this field is deplorable. If clinical results are to mean anything, these defects must be corrected. Instead of reporting a few cases benefited by ultra-violet radiation from a certain lamp with no standardized dosage given, groups of cases in hundreds or thousands should be studied. The clinical department referring the case to the physical therapy department should make the preliminary examination and diagnosis. The physical therapy department should have all lamps calibrated by such methods as suggested by Pohle (1) or Coblentz (2). The calibration of the lamps should be checked every month, for even if lamps were standardized at the time of their manufacture, serious variations would occur with the aging of the lamp and variable conditions of usage. The

dose should be such that it could be duplicated in another department. The results should be judged by the clinical department referring the case. The physical therapy department should keep careful records of the cases and report them with the clinical department. No case should originate in the hospital physical therapy department, but this department should have the entire responsibility of prescribing the treatment.

The therapeutic use of ultra-violet light in dermatology has recently been coming to the front because of more active and more accurate research. At present its use tends to be more as an adjunct method of treatment rather than a specific one.

In *psoriasis* some cases will clear up remarkably well under ultra-violet radiation, while others will fail to respond or even be made worse. In persistently recurring cases ultra-violet light may be used liberally, whereas repeated X-ray treatments are liable to produce permanent skin changes. Ultra-violet is being used to prevent the recurrence of lesions by having the patient use the lamp periodically at home, using a small dose, with the maintenance of slight pigmentation. In general, the superficial, slightly infiltrated forms, especially in fresh eruptions, respond better than long-standing thick plaques. Response is also better in those cases which have not had a previous attack, and in which the onset has been rapid. A second degree erythema is necessary, and in the treatment of thick patches a water-cooled lamp with compression may be used to shorten the time. Goeckerman (3) has reported on the use of crude coal tar ointment and ultra-violet in *psoriasis*, the effect being that of a sensitization of the lesions to the light.

In *alopecia areata* of recent origin an active hyperemia may be produced by inten-

<sup>1</sup>Read for the authors by John S. Hibben, M.D., of Pasadena, Calif., before the Radiological Society of North America at the Sixteenth Annual Meeting, at Los Angeles, Dec. 2-5, 1930.

sive doses of ultra-violet light; no improvement can be expected without a hyperemia. Hyperemia produced by irritants, where the destruction is not too great, will produce equally good results. In the old cases, especially of the universal type, ultra-violet should be tried even though the prognosis is poor. It is of utmost importance in the prognosis of these cases to make a correct diagnosis. In cases in which scar formation is the result of a disease a bald spot results from permanent destruction of the hair follicles, as in pseudopelade of Brocq, and no results can be expected.

In *seborrheic alopecia*, also, there is a tendency to a degeneration of the hair follicle, and ultra-violet light may produce a fine fuzz which does not develop further, and which tends to fall out. It has been shown that the action of ultra-violet in alopecia is not specific and that results are due to reorganized nervous and vascular tone.

In *acne vulgaris* the best result with ultra-violet light is obtained in the acute stages, where there are a small number of comedones, with some acute inflammation and a rather large amount of oily secretion. Pustular lesions are absorbed rapidly under bi-weekly doses; a first or second degree erythema is recommended by Andrews (4). The treatment of acne with ultra-violet is likely to be very slow. Patients often object to repeated heavy doses of ultra-violet light to the face. Other factors in the disease, such as endocrine disturbances, chronic indigestion, poor nutrition, etc., should be corrected.

In *tuberculosis of the skin*, such as lupus vulgaris, the production of a second degree reaction, locally, produces improvement. The clearing up of systemic tuberculosis also is a factor in the treatment of local skin tuberculosis. Reyn (5) says that a permanent recovery with slightly visible scars was manifest in 90 per cent of 104 cases of lupus, while an intensive, but only local,

treatment proved far less effectual. In this connection it is well to remember that in the presence of advanced pulmonary tuberculosis, or tuberculosis of the pleura, ultra-violet light must be used with caution.

*Pityriasis rosea* is a systemic disease whose marked symptoms are large fawn-colored lesions distributed over the trunk, together with itching, which is worse at night. The disease, of course, is harmless and self-limiting. A dose sufficient to produce exfoliation can be used to remove the lesions and to relieve the itching, leaving in their place erythema and an exfoliation, producing the discomfort of a severe generalized sun-burn. For this reason many patients prefer to have the disease run its course without the treatment.

In the *superficial fungus infections* of the skin, such as tinea versicolor, a prompt cure can be obtained by removing the organism as well as the superficial layers of the skin. This exfoliation is necessary as the fungus inhabits only the superficial layers of the skin. Keratolytic ointment, such as one-half strength Whitfield ointment, or a solution of 10 per cent sodium hyposulphite, will produce equally good results without an erythema. In *ringworm* of the feet, the difficulty of exposure of the area between the toes to ultra-violet rays is overcome by the use of an ointment. Ringworm of the scalp is better treated with agencies which will cause the temporary epilation of hair, as ultra-violet light does not penetrate sufficiently.

In *impetigo*, better results can be obtained by rigid local cleanliness, and the use of antiseptics such as 4 to 10 per cent ammoniated mercury ointment. While it has been demonstrated that the shorter wave length ultra-violet has bactericidal properties, the difficulty in its use is the lack of penetration of sufficient quantities of these shorter rays to become effective. The killing of the few organisms on the surface is not of much practical importance. An inflammatory re-

action, however, produced by a second degree erythema, does seem to produce local resistance and thus some slight improvement. This same statement might be made for other infections of the skin such as pyoderma, ecthyma, etc.

In *erysipelas*, Ude (6) has reported the use of ultra-violet in 91 patients, followed by as good results as could be expected, with other accepted methods of treatment, including roentgen radiation and antitoxin. With the use of ultra-violet, he points out that the technic is simple, inexpensive, devoid of danger, requires only one treatment, is readily available in practically all communities, and that the results are comparable to those of any other method. Becker points out the exceptionally high mortality of infantile *erysipelas*. In the German hospitals, according to Schlieppe's report (1923) of infants under one year old stricken by *erysipelas*, 78 per cent died. In America, an 80 per cent mortality was reported in 1927. Becker reports that with from one to one and one-half erythema doses at the German hospital clinic at Bonn, by the use of ultra-violet light 87 per cent were cured and that only one child died, which death was due to general infection complicated with peritonitis and bronchial pneumonia. These results are somewhat startling. While exposure to ultra-violet rays in *erysipelas* has been severely criticized by some, it deserves further study, and additional work will have to be done before a definite stand can be taken on the subject. It must be remembered, however, that other methods of treatment are far from remarkable.

The theory that ultra-violet radiation might be used to lessen the effect of a massive dose of X-ray, intentionally or otherwise given, we believe has been definitely disproven by MacKee (7). Ultra-violet might improve chronic X-ray ulcers by an improvement in the circulation and by a stimulation of granulation tissue, but otherwise is contra-indicated. Experimental

studies on the combined effects of roentgen and ultra-violet rays by Pfahler *et al* (8) show that the ultra-violet would not prevent roentgen-ray dermatitis in many of the rabbits on which they experimented. On the contrary, the ears which received combined treatment with ultra-violet and roentgen rays showed a more severe reaction than the control ears. These control ears received the same amount of roentgen-ray treatment, producing a maximum reaction in which ulceration and a sloughing off of the ears occurred.<sup>2</sup>

Contra-indications to ultra-violet therapy might include high or continued fever, marked activity of lesions, advanced cardiorenal diseases, acute pulmonary tuberculosis, smallpox, and hyperesthesias to light in such rare conditions as hydroa vaccini-forme, hydroa aestivale, and xeroderma pigmentosum.

The effects of the lack of standard methods for measuring dosage of ultra-violet radiation are illustrated by the reported results of ultra-violet radiation on the blood. In a series of 200 new-born infants short exposures of ultra-violet radiation, according to Sanford (9), increased the hemoglobin content and number of red blood cells to a slight extent in an average number of cases, and there was a rapid return to normal. Short exposures to ultra-violet radiation increased the hemoglobin content and the number of red cells to a greater extent in cases in which these elements were lower than normal, and they tended to remain normal. In contrast to this report a recent careful study (10) of forty children showed that ultra-violet radiation had no specific effect on the blood. In respect to these experiments and many similar ones, it would be impossible for another group of investigators to duplicate the dosage, as apparently neither the quantity nor quality of the radiation was sufficiently

<sup>2</sup>See also Pohle, E. A., and Wright, C. S.: *RADIOLOGY*, April, 1930, XIV, 351.

measured, nor is it recorded that variations of the individuals were considered. Thus the use of ultra-violet radiation in secondary anemias is still in the experimental stage.

Ultra-violet radiation has a definite value in the treatment of ophthalmological diseases. In co-operation with our Department of Ophthalmology, we are trying to secure clinical data on this subject.

Corneal ulcers respond well, for which a concentrated form of ultra-violet radiation should be used. In determining our dosage we used a mercury quartz water-cooled lamp on the conjunctiva and cornea of six rabbits. With this lamp at a distance of about one inch it took on the average forty seconds to secure a superficial cell destruction such as could be detected by the use of fluorescin. Therefore, we give our patients only a 30-second dose at the same distance. Local treatment is of benefit in corneal ulcer, tuberculosis of the cornea and conjunctiva, trachoma, and blepharitis. Herpetic lesions show the most marked effect of such treatment. General body radiations are of benefit in phlyctenular keratitis and in ocular conditions due to tuberculosis (11).

Ultra-violet radiation has a definite value in the treatment of wounds. The exposure should be made at every change of dressings and increased in accordance to the patient's tolerance. In the after-treatment of electrical burns, healthy granulations are encouraged by the judicious use of ultra-violet radiation, according to Fisher (12). Ultra-violet radiation is a valuable adjunct in the preparation of infected granulation tissue for skin grafting. For an infected or a sloughing wound, a continuous hot, wet dressing is used, and changed daily. When these measures have insured an adequate blood supply, ultra-violet radiation is employed in doses sufficient to render the granulations red, vascular, and free from exudates. The dose should be such as to

produce a mild erythema on the normal skin, and increased if the wound is not properly influenced. When the granulation tissue has become a firm bed of beefy red—a non-infected area—with a line of growing epithelium at the edges, conditions are right for skin grafting.

In active rickets, cod liver oil, viosterol, and ultra-violet radiation are generally accepted as specific agents in the prevention and cure in infants. Viosterol is of advantage because of its concentration. Ultra-violet radiation doubtless produces a variety of physiologic effects, including influences on the blood and circulation, that remain to be carefully evaluated. The main difficulty is the lack of information of the amount of ultra-violet radiation needed. A combination of cod liver oil, viosterol, and ultra-violet radiation seems most desirable at present. Their relative merits are under investigation. Gerstenberger (13) has been using only one exposure of ultra-violet radiation weekly to secure a mild erythema, and says he secures the same results as with larger amounts.

The dosage of ultra-violet radiation in infants with tetany was recently studied (14), and it was found that the dosage given by Gerstenberger as sufficient to cure rickets could not be relied on to cure tetany. Here again is demonstrated the disadvantage of the lack of standardization of dosage. Gerstenberger used the erythema unit of Rost and Keller and the investigators in the dosage in tetany used the oxalic acid-uranyl sulphate method to measure the intensity of ultra-violet radiation. They found the limit of optimal dosage to be between eight and thirty-eight oxalic acid units and used daily doses.

The susceptibility to common colds has been reduced 40 per cent according to Maughan and Smiley, of Cornell (15), in a series of experiments on college students over a period of several years. This has not been confirmed by like experiments else-

where, but our experience leads us to believe that ultra-violet radiation plays an important rôle in the prevention of bronchitis. Sunshine is the best source of this radiation, but artificial sources must be used in the winter months in cold climates. Here, again, is a subject for clinical investigation as to the amount of radiation needed and for a control series of cases.

The general treatment of tuberculosis by ultra-violet radiation is not placed on a proper scientific basis. The main reliance in tuberculosis is still in rest, hygiene, and diet, but ultra-violet radiation is one of the most important adjuvants in the treatment. Sunlight is still the best source of ultra-violet light. Mayer (18) believes that artificial sources of light are not to be relied upon as important aids in the treatment of pulmonary tuberculosis. Even sunlight in pulmonary tuberculosis leaves much to be desired. Also, the dangers are such as to make this form of treatment hazardous unless carried out under expert supervision. So far as cases of pulmonary tuberculosis are concerned, nothing but failure will result if cases are treated when the patient's temperature is 100° F. Treatment should be stopped then, and the patient be kept at rest in bed. Treatment can be resumed when the temperature falls to normal, and the dose must be lowered. It is probably better to under-expose the patient than to over-irradiate him.

The aim of ultra-violet radiation therapy is to find the part of the radiant energy spectrum which is specific or, at least, best adapted for use in tuberculosis. Some work has been done along this line by Phelps (16), and although it has not been confirmed, it is at least a step in the right direction. He states that the wave length band lying between 320 and 380 millimicrons was studied both clinically and experimentally and was found to be active. The chief effect is an acceleration of the processes of repair which may or may not be specific for

tuberculosis, but which is essential in the retention of function. It is an indirect effect, general rather than local. Longer exposures can be given if the erythema and tan-producing rays, 300 to 320 millimicrons, are of small quantity or absent. Erythema and pigmentation, therefore, are of no use as a basis of dosage given.

Sunlight is the treatment of choice for bone and joint tuberculosis, graduated exposures of the body usually being made, according to the method of Rollier (19), together with the agencies of diet, hygiene, and necessary surgical measures. General exposures are used, with additional local exposures over the area of disease. In bone and joint tuberculosis, a weight chart should be kept and watched carefully as this is one of the most important guides to the progress of the cases. X-ray films, with at least two views of the joints, should be made at intervals of three months. Proper orthopedic measures should always be taken.

In laryngeal tuberculosis, general body radiation should be combined with suitable local treatment. Strandberg (17), who has reported a most complete study of 203 cases of laryngeal tuberculosis, employs a treatment consisting of increasing periods of general body radiation combined with other suitable local and general treatment. He reports cures in 113 patients, or 55.6 per cent.

With proper care and conscientious supervision, the results obtained by ultra-violet radiation in tuberculous peritonitis and intestinal tuberculosis are quite encouraging. The greatest caution is necessary in the matter of exposure, and the method of gradual body exposures, starting at the feet, after the method of Rollier, should be followed with either natural or artificial radiation. The area of exposure and the time are gradually increased until the patient receives a general body radiation with additional local exposure of the abdomen.

In lymphatic tuberculosis, we have ob-

tained excellent results with ultra-violet radiation, and our experience agrees with Mayer. He says: "Tuberculous lymph nodes may be seen clinically in three different stages. In the first stage, exposure to light is followed by an inflammatory reaction, with slight pain, tenderness, and swelling. In the majority of cases the inflammation subsides, and the lymph node finally heals. About 30 per cent of these appear to the writer to show no tendency to heal under light alone; but with X-ray irradiation, in addition, a large number of these also will improve. In the second stage of caseation, ultra-violet light exposures alone will frequently bring about resolution. When softened lymph nodes reach the stage of fluctuation, aspiration or incision is necessary, and then ultra-violet radiation is most effective. In the third stage, excellent results are obtained in clearing up sinuses of long standing, but occasionally X-ray exposures may have to be combined with light treatment for complete healing to take place. Local irradiation of the sinus area should be made, in addition to general irradiation of the body. In cured cases exposures have varied from three to eight months."

Ultra-violet radiation has a place in the treatment of arthritis. Its influence is not specific, but it has a definite value when the patient has a secondary anemia or is suffering from a lack of sunlight due to confinement in bed. All our arthritic cases receive artificial ultra-violet radiation in the winter months and are instructed in sun baths in summer. Again dosage has not been determined.

We have been co-operating with the Department of Medicine in the use of ultra-violet radiation in asthma. Unger (20) of this Department says: "For about three years we have been using ultra-violet light as an accessory method of treatment. We believe it helps as a tonic and it seems to be specially valuable in the under-nourished.

We believe that it has no specific value, yet our results have certainly been improved since we adopted its use."

Recently we have tried to estimate the blood calcium in fracture cases with non-union, but in no case were we able to show a deficiency of blood calcium. Swart (23) recently showed that irradiated ergosterol given by mouth to rabbits did not increase the rate of healing or the amount of callus formed in fractures of the tibia and fibula. Murray (22) says that "fractures always heal, unless there is a mechanical bar to tissue growth." The healing is accomplished as with wounds elsewhere by the growth of granulation tissue. This granulation tissue is derived from the wounded soft parts of the bone-periosteum, endosteum, and the areolar tissue about the vessels in the narrow cavity and elsewhere.

The source of calcium for this calcification is dead, autolyzed bone at the site of fracture, and not the blood stream. Vascular changes probably induce local tissue pH changes, which may strongly influence precipitation of calcium salts from solution or colloid combination or ferment activities on large radicles of organic calcium salts. Given tissue death, a local calcium source, a vascular status producing the proper pH, and granulation tissue, bone will form without the presence of any bone cell. Bone as a calcium source can be experimentally replaced by both inorganic and organic salts of calcium. Either precipitation or ferment-splitting activity may be responsible for the calcium deposition; the latter seems the more probable. Bone and soft-part circulation are of prime importance in the process of calcification of fracture healing and should, therefore, be prime objects of attention early in the bone-healing process. The time to use elevation, heat, massage, diathermy, and active exercise is then, if possible; it is much more important than later in the course. Mouth administration of calcium and phosphorus and similar

drugs is ineffective. If calcium is needed, it must be supplied locally and not *via* the blood stream in any individual whose general calcium metabolism is normal. From the above experiments and our experience, therefore, we believe that ultra-violet radiation will not influence the union of fractures.

In concluding this brief discussion of ultra-violet radiation there are several points that apply to the use of all physical agents which we wish to emphasize: First, the urgent need of a standardized dosage; second, the use of these agents on a definite written prescription by a physician and not by a technician with generalized direction by a physician; third, these agents are only adjuncts and must, therefore, be used as aids to other medical or surgical treatment.

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## DISCUSSION

DR. H. J. ULLMANN (Santa Barbara, California): There is one point I wish to emphasize which was not spoken of in any of the papers. Any trained technician can give infra-red treatments, diathermy, massage, or gymnastic work with very little direction from a physician, and can do no particular harm if her technic is poor, but it is as absurd for a technician to give ultra-violet without the direction of a physician



as it is to give tuberculin or digitalis under the same condition. You might order a nurse to give a certain dose of tuberculin, but you would not tell a nurse simply to give tuberculin treatments. The Council on Physical Therapy of the American Medical Association and the American College of Radiology both agreed to divide radiology and physiotherapy at the ultra-violet, and that the ultra-violet belongs in the department of radiology, so that when we speak of a department of physiotherapy we should not include the ultra-violet, because there is at present much confusion regarding its proper use in many hospitals, especially the smaller ones. In these, the ultra-violet generators are frequently put in charge of a nurse in the physiotherapy department and little or no attention is paid to them by physicians. We, as radiologists, must follow the recommendations of the College of Radiology and the American Medical Association and change this situation.

There is one use of the ultra-violet that I did not hear mentioned, the so-called immunity reaction. It has been shown that if an erythema, no matter how slight or how large, so long as it is an erythema, is produced on the body over more than a certain fraction of its surface, a lowered immunity results. If it is less than this maximum fraction, there is an increased immunity. For practical purposes an erythema of not more than the front or back of the trunk or the same of the legs results in an increased immunity. If an erythema is produced over the entire body, the resistance to infection is temporarily lowered. It is also true that one can do the same thing by almost any irritation that will result in an erythema; hence the value of the mustard plaster.

I wish to disagree with the statement that ultra-violet should be used before the roentgen ray when treating acne. If an acne does not clear up after from four to six treatments with the roentgen ray, a few

mild peelings with the ultra-violet usually complete the cure. And I have found that reversing the procedure does not give as good results.

I think Dr. Coulter's paper was a little optimistic on the treatment of dermatophytosis. In California we have many such cases, and we find it necessary to treat one with Whitfield ointment and another with the X-ray, and still another with mercurochrome or carbolfuchsin compound, etc. A few benefit markedly from the use of ultra-violet, especially in combination with the Whitfield ointment, but unfortunately the procedures that will work perfectly with one patient may be an entire failure with another.

DR. RODNEY ATSATT (Santa Barbara, California): As Dr. Ullmann has said, the General Electric Company loaned us, some time ago, one of their large radio heat machines and we have been using it, among other things, for the treatment of arthritis. We have found that a twenty-minute exposure will raise the temperature about one degree Fahrenheit. If the exposure is prolonged, the temperature increases. The pulse is increased slightly during this exposure; the respirations do not change. We have treated about fifty cases so far, with about 50 per cent of them showing marked improvement, about 25 per cent more showing some improvement, and about 25 per cent of them being unchanged. The ones which show marked improvement are the ones in which the sensation of well-being and general warmth is produced by one exposure. They are the ones who get the most benefit from it. It is too early to make any definite statement as to prolonged benefit or the length of the benefit derived, but some cases have run over a year now and are still improving from the arthritic standpoint. There are metabolic changes

which go on in this heating process which have something to do with the biochemistry of the patient. We take in the trunk, hips, elbows, hands, and wrists at one treatment, and the hips and knees and lower trunk in another sitting. We believe that this machine gives better effects than diathermy as usually applied.

DR. STAFFORD L. WARREN (Rochester, N. Y.): I have been studying diathermy experimentally for about three years now, and it seems to me there are two factors not taken into consideration by all of us. One is the part played by the circulating blood in taking heat out of the area being treated by diathermy, and the other is the duration of the treatment. We have found by making thermocouple measurements in the joints, and especially the knee joint, that it takes from three-quarters of an hour to an hour to heat the joint fluid to forty-one and a half degrees centigrade. In most physiotherapy departments it is customary to give the patients a twenty-minute treatment; if

one is going to do any more than just increase the circulation in that area, for instance, if one is trying to kill the bacteria, he has to keep the diathermy on much longer than is customary. We have found that when one turns the diathermy off, the blood takes out the heat at a very rapid rate. One can prevent that by producing stasis, but we have found that that is dangerous, in dogs, at least.

I have heard considerable discussion lately about the influence of frequency in high frequency currents. We have tried direct and indirect methods of calorimetry, and we have found that within the limits of our experimental error, the effects of currents of all frequencies at our disposal are identical. Setting up two frog muscles in separate chambers (Warburg type), balancing one against the other, and using various frequencies on one muscle and the other as a control, Dr. Wallace Fenn was unable to get more heat by any of the high frequencies than he was able to get by an equal amount of sixty cycles alternating current.

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# THE MIGRATION OF EPINEPHRIN IN A NEW APPARATUS FOR ELECTRODIALYSIS

By WILLIAM DEVRIENT, STEPHEN THYSSEN, and BORIS SOKOLOFF

From the Department of Pathology, School of Medicine, Washington University, St. Louis

CONSIDERING the importance of electrodialysis in biological investigations, one of us (Sokoloff)<sup>1</sup> suggested to Dr. N. Michailovsky the construction of an improved apparatus which could be used for the study of the migration of epinephrin. Before stating the results of the latter experiments, we shall describe the new apparatus for electrodialysis.

Figures 1 and 2 show the apparatus which has been used in our work with epinephrin. The improvement concerns the construction of the glass cell in which the electrolysis is carried out. The cell is built in three parts: A., M., and C., which correspond to the anode, middle, and cathode divisions. Divisions C. and A. are attached to the middle division by two clamps in such a way as to allow them to be separated if desired. Between the three divisions it is possible to place two diaphragms with a diameter of  $3\frac{1}{2}$  inches. Each diaphragm is held in position tightly between the divisions by means of two rubber rings. Filters of various kinds can be used in combination with these diaphragms. The electrodes are removable, so that it is possible to use different kinds of electrode material. They have an area of 38 sq. cm., and are made of fine wire mesh. The glass cylinders which form the anode and cathode divisions have circular openings about  $\frac{1}{2}$  inch in diameter through which it is possible to withdraw or add the solution of epinephrin and also to observe the temperature. It is possible to let water circulate through the Divisions A. and C. by means of suction and in this way to replace the used liquid with new fluid, thus assuring a perfect removal of electrolytes. Figure 1 shows an arrangement in which water circu-

lates through the two side divisions containing the two electrodes. The big flask, D, on the left contains distilled water which is drawn up into Divisions A. and C. by means of a vacuum pump (v) and is collected in the two smaller bottles ( $B_1$  and  $B_2$ ). The vacuum is indicated by a manometer, E, which is attached on top of the control board. The cell in which the electrodialysis is carried out is attached in such a manner that it can be rotated by means of the agitator, F, which is operated by a compressed air motor.

The apparatus can be operated by a direct or alternating current, using a wide range of current intensity and potential. It is possible to take readings from one milliamperere to ten amperes and from one to one hundred and fifty volts. Indicators are provided to take readings by alternating and direct current. A sensitive rheostat, R, is connected in the circuit of the ammeters. The conditions of the middle division are such that primarily only dissociation and migration can occur. We used as diaphragms Norton Alundum Filter Discs  $3\frac{1}{2}$  inches in diameter and  $\frac{5}{32}$  inch in thickness, having a porosity of 43.9 per cent. At 20° C. the electrical resistance of this filter disc is  $9 \times 10^8$  ohms, cm. cube.

With the apparatus described above, we carried out at first a series of migration experiments with epinephrin. Next we followed the behavior of the epinephrin during the process of electrodialysis. For this purpose we added epinephrin to the middle division of the cell in order to study a possible migration of the substance through different membranes, like the Norton Alundum membrane mentioned above. In addition, we used ultra-filtration membranes and cella

<sup>1</sup>Compt. rend., 1929, CL, 888.

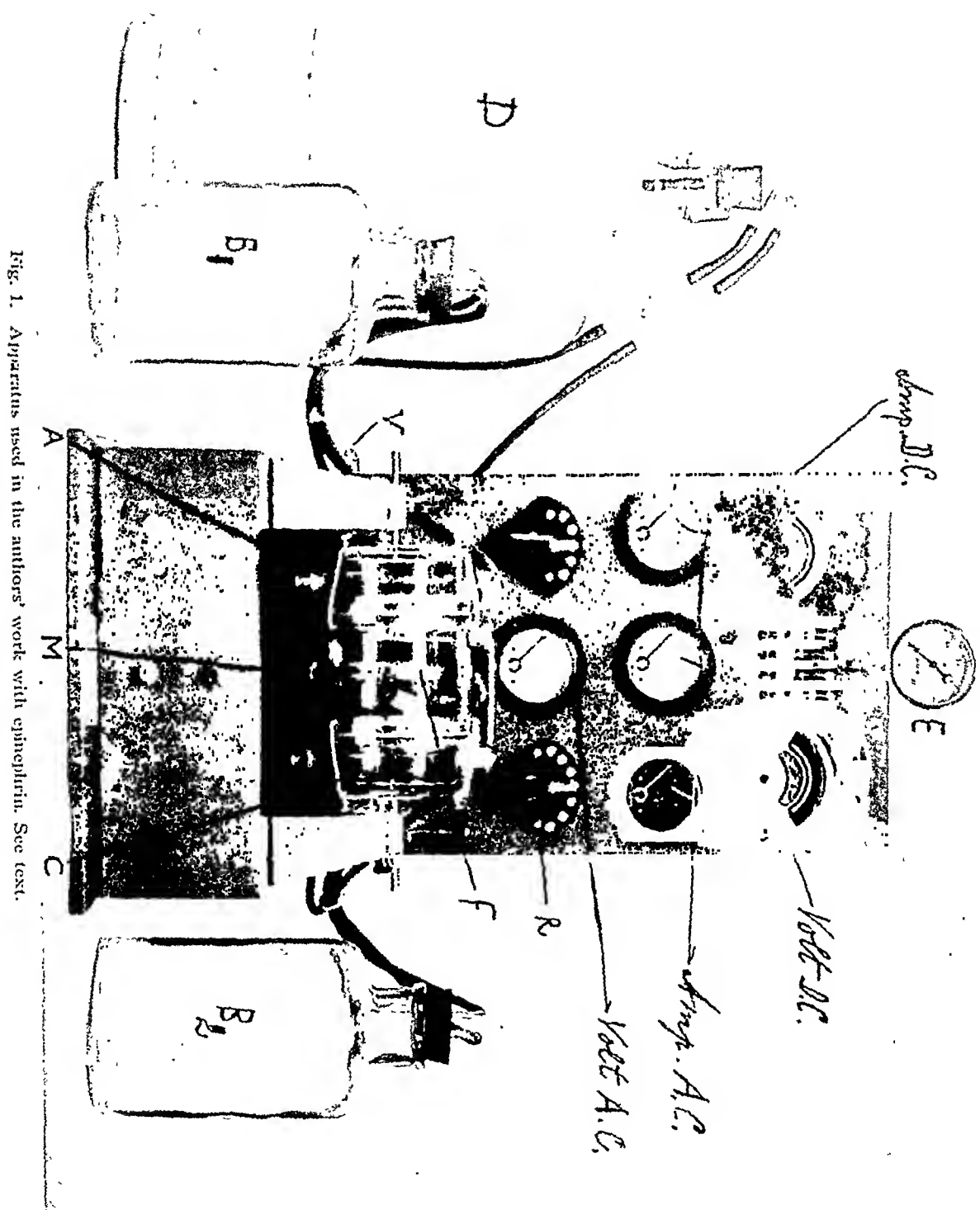


Fig. 1. Apparatus used in the authors' work with epinephrin. See text.

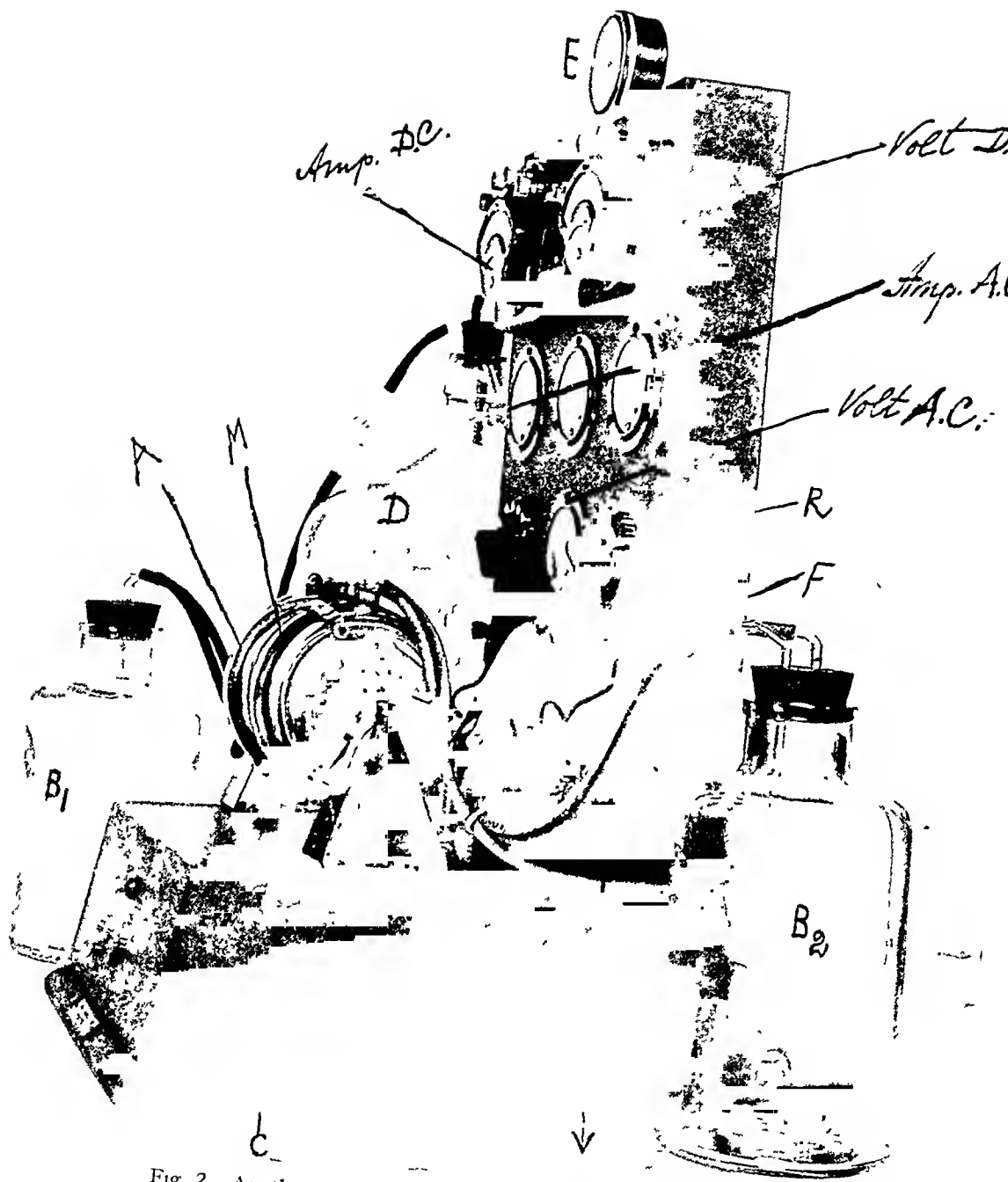


Fig 2. Another view of the authors' apparatus See text.

filters of Zsigmondy in combination with the Alundum diaphragms

Our investigations were carried out in the following manner: The migration of epinephrin from the middle division to the side divisions was observed in acid, and neutral,

in alcoholic as well as in salt solutions. The possibility of reverse migration from the two electrode divisions to the middle division was also considered.

It was proved that under the influence of direct current a migration of epinephrin oc-

curs in the directions toward both electrode divisions. The first experiments were carried out under continuous circulation of water in the electrode divisions. Epinephrin in aqueous and alcoholic solutions which had

nephrin in the direction of both poles occurs unequally. A more pronounced migration could be found to take place in the direction of the anode than in the direction of the cathode. In this way it was found that

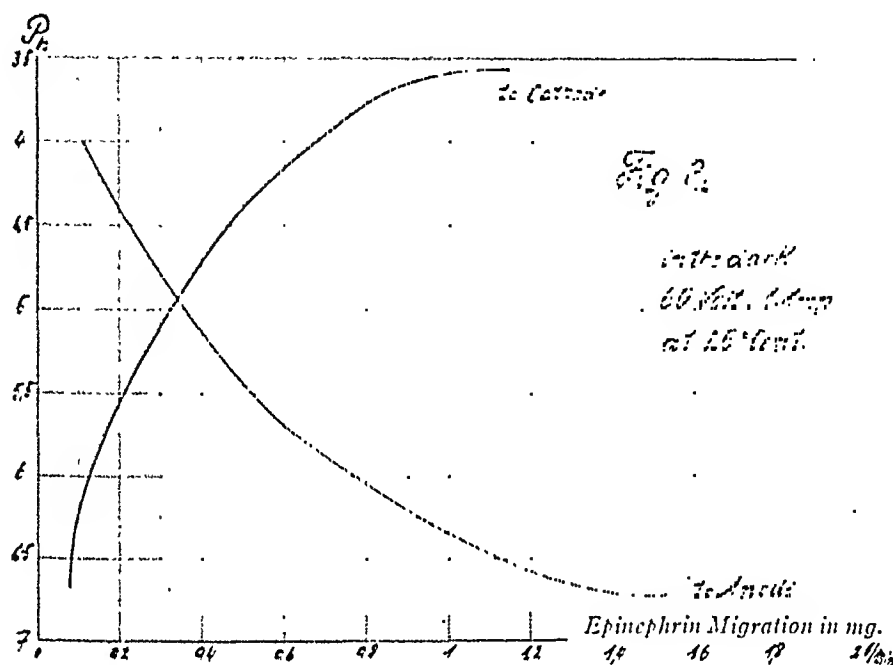


Fig. 3. Curve showing the influence of pH on the migration of epinephrin.  
See text.

been added to the middle division was removed from this part of the apparatus by migration toward the electrodes. Using a current of 40 milliamperes and 60 volts, 10 milligrams of epinephrin hydrochloride in an aqueous solution of pH 4.2 could be removed by means of dialysis in eight hours, and it was found in the circulating wash water. Quantitative investigations showed that about 30 per cent of epinephrin removed was decomposed by electrolysis under the action of air and light. Epinephrin was not retained by the Alundum discs nor by the various Zsigmondy filters. The same results could be obtained by using epinephrin in alcoholic solution. Quantitative experiments showed that the migration of epi-

after the addition of alkali or alkaline salts to a solution of epinephrin hydrochloride a greater migration occurs to the positive pole and that the addition of acid or acid salts effected a greater migration in the opposite direction. The following table presents experimental results obtained by adding different electrolytes.

A current of 60 volts and 4 milliamperes at 25° C. was applied to 20 milligrams of epinephrin solution of pH 4.2.

After five hours the amount of epinephrin which was present in each of the three divisions was determined. The quantitative experiments were carried out by the Folin method as modified by Hitchcock and Benedict, using the colorimeter of Duboscq. An

TABLE I

|             | Added | .01 N | HCl | Added | .01 N | NaCl | Added | .01 N | KOH |
|-------------|-------|-------|-----|-------|-------|------|-------|-------|-----|
|             | A.    | M.    | C.  | A.    | M.    | C.   | A.    | M.    | C.  |
| Exp. 1..... | 1.7   | 13.4  | 1.9 | .7    | 15.6  | .8   | 3.7   | 12.4  | 1.3 |
| Exp. 2..... | 1.4   | 13.8  | 2.0 | .5    | 15.2  | .8   | 3.1   | 11.9  | 1.9 |
| Exp. 3..... | 1.6   | 13.7  | 1.7 | .9    | 14.9  | .7   | 3.8   | 11.1  | 1.8 |

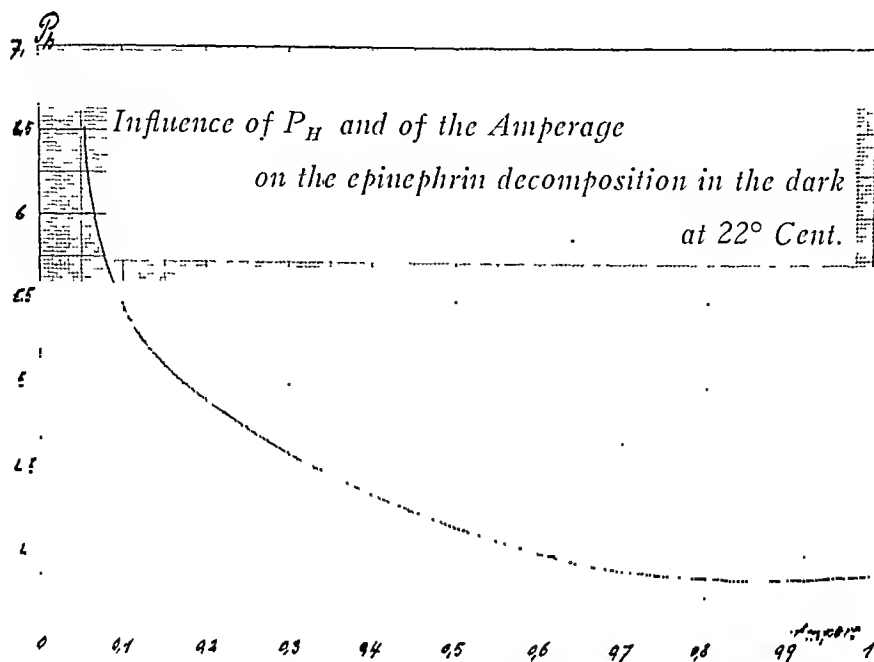


Fig. 4. Curve indicating the influence of the pH and the amperage upon the decomposition of epinephrin.

average of about 15 per cent of epinephrin was decomposed by these experiments in all three divisions. Considering the results indicated in the table we can see that in a solution of HCl more epinephrin was found to be present in the cathode division than in the anode, and, therefore, we can draw the conclusion that under these conditions a migration to the cathode is predominant. Using a NaCl solution a migration from the two electrode divisions to the middle division seems to occur. This phenomenon can be explained by assuming that by electrolysis at the anode acid will be formed and at the cathode alkali will be formed, and that these secondary products effect a change in the electric charge of the epinephrin. As a result of this reversion in the electrical charge of epinephrin, this substance will now be carried

away from the pole in the direction of the middle division. We found that at a certain hydrogen concentration the migration in the direction of the cathode and of the anode will be about equal. Figure 3 shows the influence of pH on the migration of epinephrin. The point where the curve representing the anodic migration intersects with the curve representing the cathodic migration has a pH of 5.1, using a current of 60 volts and 0.100 milliamperes at a temperature of 25° centigrade. The equilibrium point is naturally dependent upon the strength and potential difference of the currents which are used. The hyperbolic curve in Figure 4 indicates the influence of the pH and the amperage upon the decomposition of epinephrin. It will be noted that lowering the current intensity causes a fall in

the equilibrium to pH 7, however, without ever reaching this point. This character of the migration of epinephrin under the influence of an electric current suggests the possibility that movements of epinephrin in the adrenal gland, as well as in other directions in the living animal, may also be influenced by electrochemical factors.

Presumably this influence could be effected by various kinds of potentials. We may, furthermore, conclude that epinephrin behaves electrochemically like an amphoteric substance in which, in neutral solution, the basic character is somewhat predominant.

The new apparatus can be used for various biological studies. As was reported (Proc. Soc. Exper. Biol. and Med., 1930, XXVIII, 79, 80), in order to study the behavior of the living tissue in the described apparatus, we have undertaken the investigations on *Paramaecium caudatum*, chicken-sarcoma Rous, and other cancerous tissues, as Flexner carcinoma and sarcoma No. 10 and No. 39.

This apparatus can also be used for

studies of the influence of X-rays upon dialysis.

#### CONCLUSIONS

1. The apparatus constructed by Dr. N. Michailovsky for electrodialysis has been tested and found useful for biochemical purposes.

2. The migration of epinephrin passing in this apparatus through Alundum membranes and various ultra-filters of Zsigmondy was analyzed.

3. The migration of epinephrin to both electrodes varies with the pH of the solution and the strength of the current.

4. The amount of epinephrin migrating to the electrodes using varying strengths of current and different pH was determined.

5. The pH of the solution has, as we found, a pronounced influence on the direction of the migration of epinephrin.

6. At a certain pH of the solution epinephrin behaves in an electric current like an amphoteric substance, in which the alkaline character is predominant.



# CASE REPORTS AND NEW DEVICES

## FINAL REPORT ON A CASE OF BONE CYST OF THE PATELLA

By WALLACE H. COLE, M.D.,  
ST. PAUL, MINNESOTA

In 1925 the author reported a case of what was apparently a cyst of the patella, which had remained cured for nearly two years following resection of part of the patella.<sup>1</sup> As this case is somewhat unique and has been followed at intervals up to the present a further report seems justified at this time, not only to show the result of the treatment of the tumor but also to show the effect on the knee joint of removal of part of the patella.

The patient, a woman 31 years of age,

<sup>1</sup>Primary Tumors of the Patella Jour Bone and Joint Surg, July, 1925, VII, 637

was first seen on November 5, 1921, at which time she complained of pain in the left knee on going up or down stairs, inability to kneel upon that knee on account of pain, and limitation of extension of the joint. These symptoms had developed during the previous three months, following a comparatively slight fall upon the knee thirteen months before. At no time had there been any discomfort while the joint was at rest. The history was otherwise negative, except for an old syphilitic infection which had received such very active treatment that six negative Wassermann tests had been obtained during the last year.

Examination was negative objectively except for a limitation of active extension of the knee to about 160°. Passively, full ex-

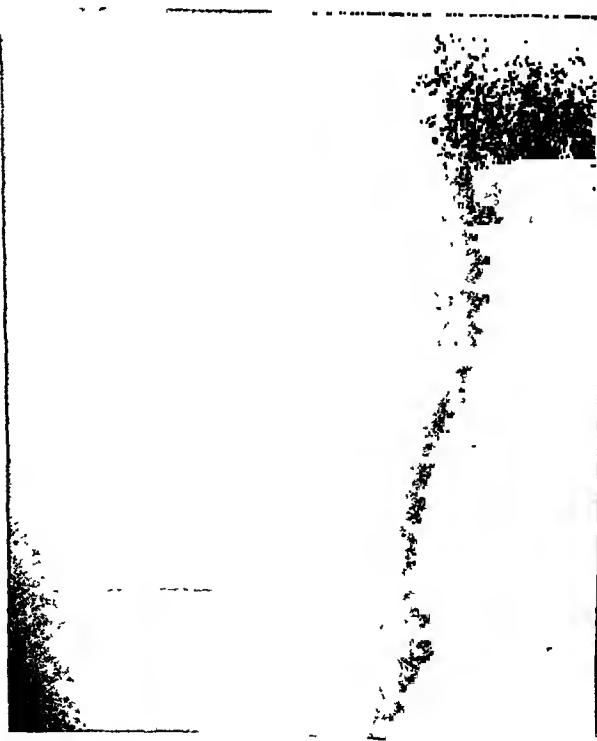


Fig. 1. Roentgenogram of knee showing a rarefied cystic condition in lower part of patella. Taken on November 3, 1921



Fig. 2. Roentgenogram of patella taken on December 2, 1921, showing increase in rarefied area, with definite projection of tumor tissue into knee joint.



Fig. 3 Photomicrograph of lining membrane of cyst, showing giant cells and a highly cellular osteitis fibrosa

tension was possible, but a painful catch was present at one point during this procedure. Palpation revealed slight tenderness over the lower part of the patella.

A roentgenogram brought in by the patient and taken on November 3, 1921, showed a rarefied, cyst-like condition in the lower part of the patella, with apparently an intact bony shell, although in the light of later roentgenograms there was probably some roughening of the articular side of the lower third of the bone (Fig. 1). Treatment was delayed for further study. A second roentgenogram was taken on December 2, 1921, and this showed that the condition was progressing and that the posterior wall of the patella had broken down, with the projection of what was presumably tumor tissue into the knee joint cavity (Fig. 2). A diagnosis of solid or cystic tumor was made, although the possibility of tuberculosis or syphilis was discussed.

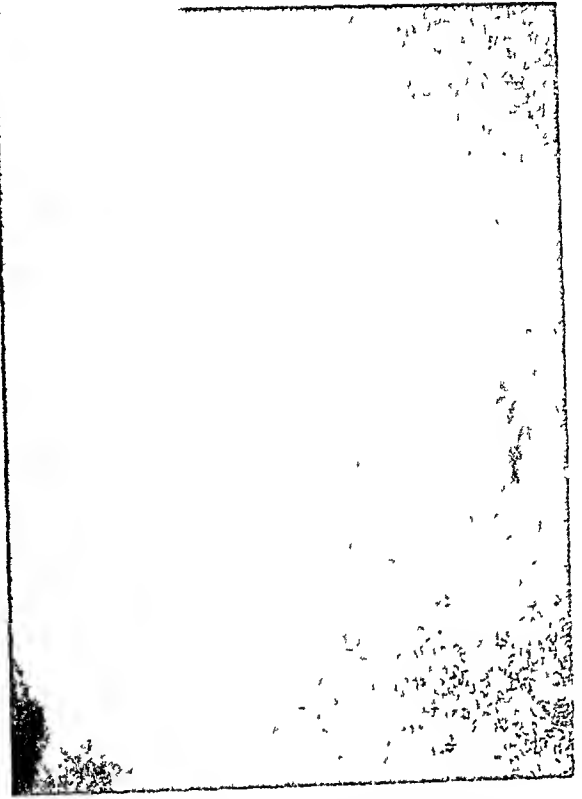


Fig. 4 Roentgenogram of patella taken on March 6, 1922, two months after curettage of cyst. Shows cavity apparently filling in with new bone. The projection into the joint is still present.

On January 10, 1922, the patella was operated upon and a piece of the anterior wall removed, disclosing a cavity containing clear fluid and lined with what appeared to be granulation tissue. The posterior wall of the cavity had perforated into the knee joint. A thick lining membrane was stripped from the anterior wall of the cavity, but no definite lining other than the thin granulation tissue-like material was found otherwise. On curetting, this tissue bled very freely and, to control this, a pack was inserted. Two days later the pack was removed and the wound went on to perfect healing.

Pathologically, the gross specimens resembled small blood clots except for the lining membrane, which could be stripped from the fragment of bone removed from the anterior surface of the patella. This latter tissue alone could be sectioned and mi-



Fig 5 Roentgenogram of patella taken on August 21, 1922, showing definite recurrence of cystic tumor.

roscopically showed what was, apparently, a highly cellular osteitis fibrosa, with mitotic figures common and some giant cells. Dr. Bloodgood examined the slides and reported the diagnosis and classification as "bone tumors — osteitis fibrosa — cyst — patella" (Fig. 3).

The patient's convalescence was uneventful and, except for a slight limitation in the extreme of flexion, the full range of motion returned to the knee joint. A roentgenogram taken on March 6, 1922, showed a cavity filling in with new bone, but with still a definite mass projecting into the joint cavity (Fig. 4). Some tenderness returned

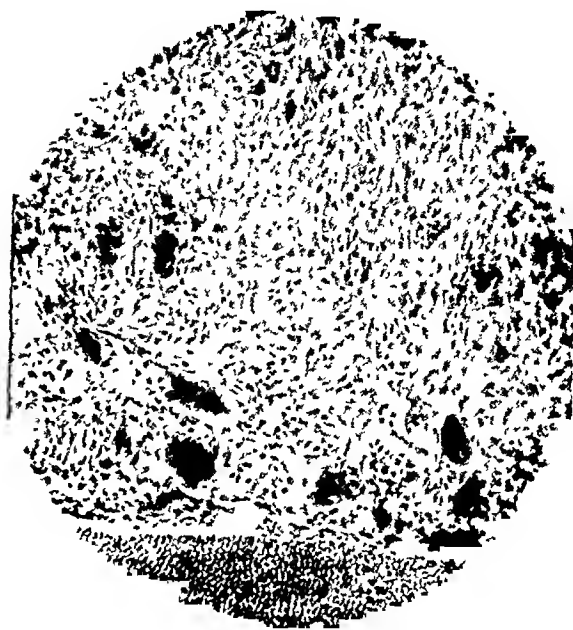


Fig 6 Photomicrograph of tissue removed at second operation. Note similarity to structure shown in Figure 3.

over the lower part of the patella by August, 1922, and a roentgenogram taken on August 22 showed a definite recurrence of the cystic condition (Fig. 5).

The patient did not allow a second operation until March 13, 1923, but on that date a resection of the lower half of the patella was performed and the raw surface of the remaining portion cauterized with pure phenol. The wound healed uneventfully and in two weeks the patient was walking around with crutches. The pathology of the tissue removed at this operation was practically the same as that found primarily. There were many giant cells but not enough to classify the growth as a giant-cell tumor (Fig. 6).

The roentgenogram taken on May 18, 1923, shows the extent of the resection (Fig. 7). At this time the function of the knee was absolutely normal. Since that time the patient has been seen at intervals and at



Fig. 7. Roentgenogram of patella taken on May 18, 1923, two months after resection of the distal half of that bone.



Fig. 8. Roentgenogram of patella taken on July 8, 1924, showing condition sixteen months after partial resection.

no time has the knee given any trouble. The woman is of heavy build but very active, and bowling is one of her frequent recreations.

A film taken on July 8, 1924, showed absolutely no signs of recurrence and a definite "rounding off" of the resected surface of the patella (Fig. 8). No apparent change has occurred since that time, and a roentgenogram taken on October 28, 1930, can hardly be distinguished from the one taken in July, 1924 (Fig. 9).

We have here, therefore, a case which seems to fit definitely into the class of osteitis fibrosa with cyst formation, the lesion

being in the patella, a situation which has never been mentioned in the literature by anyone so far as can be found.

Cure can definitely be claimed, as the knee has been functionally normal over a period of more than seven years following resection, and roentgenograms have shown no changes taking place in the patella during the last six years. There has been no apparent tendency toward arthritis in the knee joint, even with the lower half of the patella gone, and the remaining portion seems to function as perfectly as does the entire bone in the other knee.



Fig 9. Roentgenogram of patella taken on October 28, 1930. It is difficult to see any difference between this film and the one taken six years previously (Cf Fig 8)

## A CASE OF RECURRENT GIANT-CELL TUMOR OF THE LOWER RIGHT RADIUS

By J. SHELTON HORSLEY, M.D.  
RICHMOND, VIRGINIA

The patient whose case is reported, Miss L. V., aged 37 years, stenographer, first consulted me on April 13, 1928. Her family history was negative for malignancy. The patient's general health had been good except for two fairly severe attacks of influenza, and paratyphoid about 1924. She had been extremely nervous and had had three or four "nervous breakdowns." She

had gained weight during the past year. Wassermann tests were consistently negative, and other laboratory examinations were negative.

She had noticed a tumor at the lower end of the right radius for at least two years before I first saw her (Figs. 1, 2, and 3). The growth had been treated with X-rays and finally was operated upon elsewhere about the first of April, 1927, the growth being thoroughly curetted. Roentgenologic examination on October 21, 1927, seemed to show a recurrence (Fig. 4).

When I saw her there was a tumor of the lower end of the right radius, appearing chiefly on the palmar surface (Figs. 5 and 6). The skin over it was stretched rather tightly and seemed to be quite vascular, though it was not definitely adherent to the growth. No axillary lymph nodes were palpable.

On April 25, 1928, I operated, under local anesthesia, resecting the lower end of the right radius, with the immediately surrounding soft tissue, doing all of the dissection with the endotherm knife except that the bone was divided with bone forceps. The block dissection included the adjacent tendons around the lower end of the radius. After removing this mass there appeared to be a small amount of tumor tissue between the tendons. This was dissected away with the endotherm knife. The head of the metacarpal bone of the thumb was removed with forceps. The bone after division was immediately cauterized with the coagulation current.

Histologic examination showed a typical giant-cell bone tumor. There were many giant cells and a stroma of spindle cells and connective tissue. The tumor was rather cellular. There were no mitotic figures (Fig. 7).

The patient made a satisfactory recovery, the wound healing without infection. Roentgenologic examination May 15, 1929, showed no evidence of recurrence (Fig. 8).

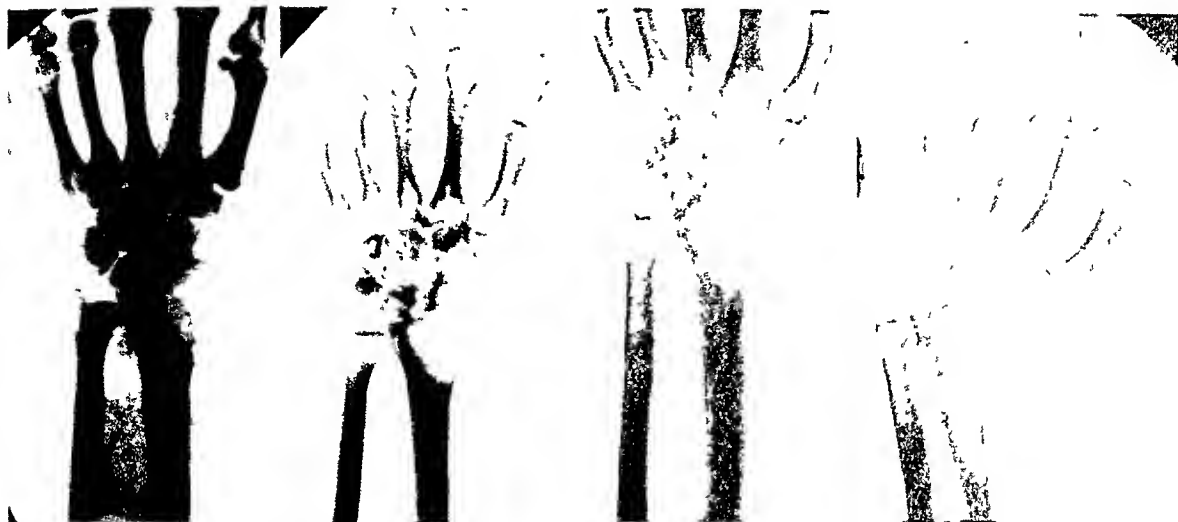


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 1. Roentgenogram of right wrist (January 29, 1927).

Fig. 2. Roentgenogram of same wrist (February 3, 1927).

Fig. 3. Roentgenogram of same wrist (March 28, 1927). This and the two preceding films were made by Dr. V. W. Archer, at the University of Virginia, shortly before X-ray treatment and operation by Dr. Joseph C. Bloodgood.

Fig. 4. Roentgenogram by Dr. V. W. Archer of same wrist (October 21, 1927), about seven months after the operation by Dr. Bloodgood, showing apparent recurrence of the tumor.



Fig. 5.



Fig. 6.

Fig. 5. Photograph (April 24, 1928), of the palmar surface of the right wrist, showing the recurrent growth which also involved the soft tissues around the lower end of the radius.

Fig. 6. Radial view of the recurrent growth (April 24, 1928).

On May 16, 1929, I operated upon her again for reconstruction of the right wrist, the operation being done under ethylene

anesthesia. The stump of the radius was exposed, and the tip of it cut off with bone forceps. The lower ulna was exposed for



Fig 7 Photomicrograph of tumor tissue, removed (April 25, 1928). There are numerous giant cells of foreign body type, and rather vascular stroma. The blood vessels appear about normal ( $\times 250$ ).



Fig 8 Roentgenogram by Dr. Fred M. Hodges of same wrist (May 15, 1929), nearly thirteen months after the removal of the recurrent giant-cell tumor. There is no evidence of recurrence, but a marked deformity due to the defect in the radius.

about four inches, and divided with bone forceps about one and one-half inches from its end. With the electric drill the distal end was hollowed out, and the proximal end of the radius was drilled. A bone peg was cut with the electric saw from the ulna and made to fit into the distal fragment of the ulna and the proximal end of the radius as a medullary graft. The end of the graft in the radius and the ulna were held in position to the bones of the wrist joint with sutures, and a strip of preserved fascia was wrapped around these bones in such a manner as to interfere with the tendons as little as possible (Fig. 9).

The patient was last heard from July 25, 1930, and there seemed to be no evidence of recurrence. However, it is interesting to note the gradual absorption of the graft and of the lower end of the ulna (Figs 10

and 11). The bone peg seems to have disappeared and the transplant of the end of the ulna onto the end of the radius has been largely absorbed. The distal portion of the ulna from which the bone peg was taken has also been absorbed to a marked extent. There appears to be no return of the growth, but the cause of the absorption of the graft is difficult to determine. Whether it may be due to some constitutional condition, to intensive treatment with X-ray, or to the dissection with the endotherm knife, it is impossible to say. It seems, however, under the existing conditions that any

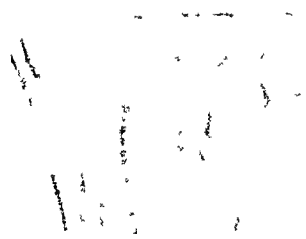


Fig. 9. Roentgenogram by Dr. Fred M. Hodges of same wrist (June 7, 1929), twenty-two days after reconstructive operation in which a portion of the ulna was transplanted with a bone peg taken from the shaft of the ulna, to the end of the radius. X-ray shows the wrist in good position and the alignment of the ends of the bones satisfactory.


further bone-grafting would be inadvisable, and that a brace or splint will be the most satisfactory means of maintaining such function as she has.

### ADENOCARCINOMA OF THE BREAST: CASE REPORT

SIX-YEAR INTERVAL FOLLOWING AMPUTATION OF THE BREAST—FINAL GENERAL OSSIOUS METASTASIS

By G. S. FOSTER, M.D., Surgeon to the Luey  
Hastings Hospital  
MANCHESTER, NEW HAMPSHIRE

The patient, Mrs. L. P., female, white, aged 49 years, married for 20 years, by oc-



*For caption, see next column*



Fig. 10 (left). Roentgenograms by Dr. V. W. Archer of same wrist (November 22, 1929). The bone peg has apparently been absorbed and the wrist has been displaced forward. The lateral view shows marked atrophy of the end of the ulna.

Fig. 11 (right). Roentgenograms of same wrist (July 25, 1930), showing an accentuation of the condition shown in Figure 10. The bone transplant at the radius is still further absorbed, and the end of the ulna has also undergone further absorption. There is no evidence of recurrence of the tumor.

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7 25 30





Fig. 1. Roentgenogram of lung field



Fig. 2. Metastases to the bones of the pelvis.

cupation a housewife, was admitted to the hospital on May 3, 1923.

*Family History.*—Father died at the age of 71 years of “cancer of the throat”; mother died at the age of 70 years of “apoplexy”; no brothers; one sister living, well and strong

*Chief Complaint.*—The first sign noticed by the patient of any abnormality, about

one week before admission, was that the nipple of the right breast was a trifle sunken, whereupon she observed her breasts closely and discovered a “swelling” in the right breast—it felt hard and was about the size of a hen’s egg. This was not tender “to handle and there was no discharge from the nipple,” the patient stated. Feeling concerned regarding this discovery she im-



Fig. 3. Metastasis to the humerus.

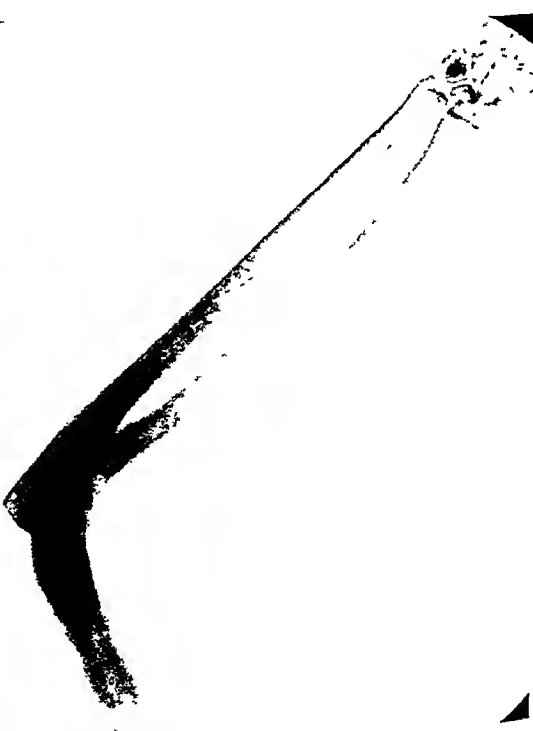


Fig. 4. Metastasis to the radius.

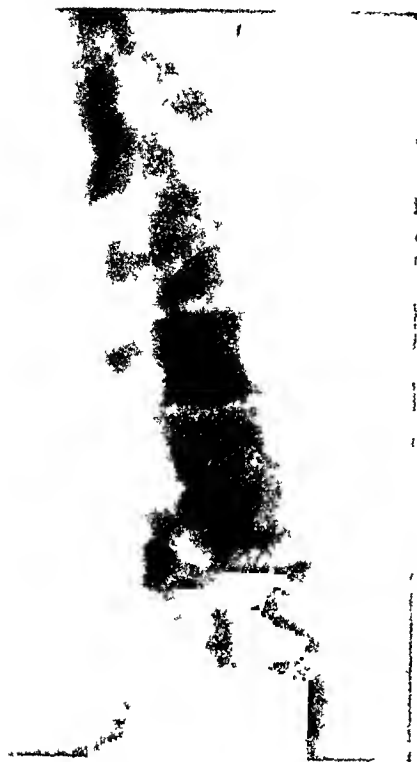


Fig. 5. Lateral roentgenogram of the spine, showing metastasis

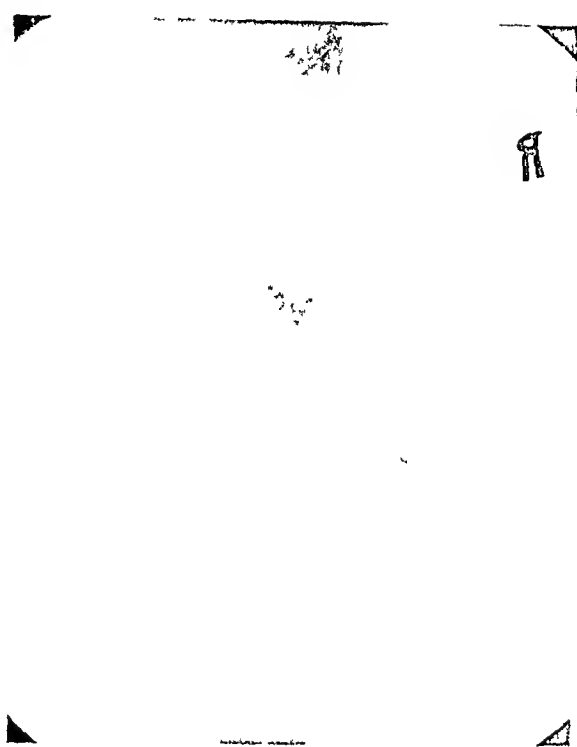


Fig. 6. Roentgenogram showing involvement of the tibia.

mediately went to her family physician, Dr. Samuel Cogswell, who recognized the importance of the situation and referred her to the hospital. During the following two years she lost no weight and felt well and strong.

There is no family history of tuberculosis, insanity, epilepsy, diabetes, or Bright's disease. Her father died of "cancer of the throat" at the age of 71 years, as stated above. The patient is prone to constipation; has a good appetite; sleeps well; micturition is normal; never has had any burning or smarting. In childhood she had chicken pox, measles, and mumps, with good recoveries; at 10 years of age, scarlet fever, with good recovery; at 20, diphtheria, with good recovery, no complications; at 26, typhoid fever (severe), but made good recovery finally, no complications. Other than the above-mentioned sicknesses she has always considered herself

as vigorous and strong, compared to other women. There was no history of injuries or surgical operations. Her habits were normal, including the drinking of tea and coffee.

Menstruation had been established at the age of 16 years; always regular; flows five days; very little pain precedes the establishment of flow; color is generally bright red with no clots. Venereal disease is denied. No leukorrhea.

*Parturition.*—Two boys, one girl; oldest 25 years of age, youngest 12 years of age; normal deliveries; no miscarriages; all children living and well.

*Climacteric.*—During the past year she has three times skipped a menstrual period. Patient thinks she is undergoing the menopause.

*Working Diagnosis.*—After physical examination, a malignancy of the right breast.



Fig 7 Metastasis to the skull

*General Condition.* — Temperature, 98.6°; height, 5 ft, 8 in; weight (normal), 142 pounds; pulse rate, 80, pulse character, good; blood pressure, 130(s), 80(d); respiration, 16, character of respiration, even and full; nutrition, well developed and nourished, general appearance of one in very good health, no evidence of recent, sudden loss in weight; teeth, all extracted; tongue, furred and moist; head, normal in size and shape; scalp, good growth of hair, no eruptions, brunette type; face, good countenance, no eruptions; neck, normal in size, no tumefactions seen, no enlargement of the thyroid gland, no lymphatic nodules; eyes, brown, no discolorations, pupils equal, react to light and accommodation; ears, hearing normal, no deformity; nose, no obstructions in either naris; throat, mucosa slightly roughened, tonsils normal, no leukoplakia present; skin, clean and clear, no discolorations, ulcerations, indentations, depressions, elevations, contrac-

tions, pigment areas, or scars noted; no spinal curvature, paralyses, or deformities noted; sinuses, clear; thorax, normal in shape and outline, respiratory excursion even; heart, no abnormal sounds, areas of dullness outlined as normal; lungs, clear and resonant, no dullness or râles detected.

*Vascular System.*—No enlarged or tortuous veins seen, no enlarged superficial veins; arteries, seem normal in size, without thickening.

*Muscular System.*—Seems well developed; no discolorations; good co-ordination.

*Osseous System.*—No bowing or exostosis; no nodular areas found along shafts of various bones; no discolorations or deformities seen.

*Nervous System.*—Reflexes seem normal; surface senses as pain, touch, pressure, and reaction to thermic changes normal.

*Breast (Right).*—This breast appears normal in size, slightly pendulated; muscles of this region are rather soft and flabby. No discharge could be expelled from the nipple. The areola was deeply pigmented. The nipple was drawn slightly inward and downward at its outer margin. The skin could not be moved over an area about the size of a twenty-five-cent piece. A nodular mass about the size of a hen's egg was present in the outer lower quadrant of the breast. It was freely movable over the underlying fascia, was rather irregular in outline, and not tender or sensitive.

*Abdomen.* — Flat, thin, fairly well muscled wall; no points of tenderness or muscular rigidity; Meltzer +; no masses felt; no suggestion of induration; no glands, edema, or ascites.

Hepatic lower border not felt; hepatic area of dullness not increased; spleen not enlarged; neither kidney lower pole felt; stomach and transverse colon not dilated as outlined by percussion; no evidence of hernia, hemorrhoids, fistula, or varicose veins.

*Vaginal Examination (per speculum).*—The cervix appears normal in size, with one



Fig. 8. Photomicrograph of metastatic nodule from breast carcinoma, removed from bone.

## LABORATORY FINDINGS

## Urine

|                          |                   |
|--------------------------|-------------------|
| Date                     | May 3, 1923       |
| How obtained             | Catheterization   |
| Amount, single           | 10 ounces         |
| 24 hours                 | 42 ounces         |
| Color                    | Amber             |
| Appearance               | Turbid            |
| Reaction                 | Acid              |
| Specific gravity         | 1028              |
| Albumen                  | Very slight trace |
| Sugar                    | None              |
| Casts                    | None              |
| Renal test               | 1° 45 per cent    |
| Renal test (May 4, 1923) | 2° 70 per cent    |

## Blood

|                           |                           |
|---------------------------|---------------------------|
| Date                      | May 3, 1923               |
| Hemoglobin                | 75 per cent               |
| Coagulation time          | 3 minutes                 |
| Erythrocytes              | 4,260,000                 |
| Leukocytes                | 14,800                    |
| Polychromatophilia        | 56                        |
| Small lymphocytes         | 29                        |
| Large lymphocytes         | 10                        |
| Eosinophils               | 4                         |
| Myeloblasts               | 1                         |
| Serum reaction            | Wassermann negative       |
| Cultures, parasites, etc. | Vagina shows normal flora |

## OPERATIVE RECORD

small left lateral tear, triangular in form. There is no discharge from the external os, which appears normal. The vaginal mucosa is moderately redundant, with a slight degree of cystocele and rectocele. A culture was made and a smear taken, both showing a normal vaginal flora. Bimanual examination shows the cervix to be freely movable. The fundus uteri is found slightly posterior, normal in size, freely movable, and regular in outline. No tenderness or sensitiveness is elicited in this part. The broad ligaments are not thickened and the tubes and ovaries appear normal, with no tender or sensitive areas. No glands are felt.

*Rectal Examination.*—Mucosa is smooth, not redundant; no enlarged tortuous veins; no ulcerations or tumefactions are seen.

A consultation was held with Dr. S. J. Cogswell and the subject matter reviewed. The patient and her husband were advised of the gravity of the condition and the future possibilities explained. Operation was done two days later.

*Post-operative Diagnosis.*—Malignancy of the breast (right): adenocarcinoma.

*Pre-operative Diagnosis Complete.*—Malignancy of the breast (right).

Temperature, 98.6°; respiration, 16; pulse, 80; blood pressure, 130/80; general condition, good.

*Condition during Anesthesia (Ether).*—Pulse remained good quality; respirations were even and full; no stimulation was required.

*Operation.*—Jackson flap, amputation of right breast. A hard, nodular mass the size of a hen's egg was found, with the subcutaneous surface attached to the lower, outer margin of the nipple, producing a moderate degree of retraction of the latter. In the right axilla were found two glands the size of peas. These glands were moderately hard, regular in outline, globular, buried in adipose tissue, and not adherent. The covering of the blood vessels was normal.

*Microscopic Findings.*—Section of the growth showed considerable connective tissue infiltration scattered between multiple

areas of adenomatous tissue which varied in size and outline. Many of these glandular areas had the basement membrane broken through and the large, irregularly shaped cells protruding through these openings were found to be widely scattered in the surrounding tissue. The pathological diagnosis was adenocarcinoma.

There was no post-operative hemorrhage or shock. The patient made an uneventful recovery and returned to her home at the end of three weeks. At the time of discharge she had full use of her right arm. Subsequent to the operation she was given Coley's fluid and two treatments of X-ray therapy.

For six years following her discharge from the hospital the patient enjoyed the full vigor of health. Over a period of two years she regularly reported to Dr. Cogswell for examination of the operative field. In June, 1929, about six years after the operation, she began to lose weight and strength and found that she could not get about the house and do her work without abnormal fatigue. During the next six

months this condition gradually grew worse and she went to her physician for examination at this time.

Dr. Cogswell reports that he found no signs of local recurrence and the pelvic organs were negative. The left breast and axilla were normal. There was a very general muscular flabbiness and the patient moved about slowly, complaining of pain in her spine and hips as well as in the arms. He referred her to Dr. J. S. Bragg for a complete X-ray examination of the osseous system. This X-ray survey revealed a marked involvement of the upper end of the radius, skull, humerus, upper end of the femur, upper end of the tibia, and a few spots in the upper end of the fibula.

The patient gradually lost weight, grew very weak, and in May, 1930, became bedridden. She progressively grew weaker and died in August of the same year. The

cause of death was general osseous metastasis involving the bones named.

## A USEFUL POSITION FOR EXAMINING THE FOOT

By HOWARD P. DOUB, M.D.,

Department of Roentgenology, Henry Ford Hospital,  
DETROIT, MICHIGAN

For some time we have been using a position for examining the tarsal bones, which has certain advantages over the standard dorso-plantar and lateral positions. Inasmuch as this does not appear to be standardized, we have felt that a brief description of the position as we use it will be worth while.

In this position, the foot is inverted, with the outside elevated to a thirty-degree angle with the film holder (Fig. 1). The central ray is directed perpendicularly to the film and centered over the tarsal bones. We have found that if the angle which the foot makes with the film is increased more than thirty degrees, the external cuneiform tends to be thrown over the other cuneiform



Fig. 1. Roentgenogram showing foot inverted, with the outside elevated to a thirty-degree angle with the film holder.



Fig 2 Roentgenogram showing result from using position shown in Figure 1



Fig 3 Roentgenogram demonstrating coalition of the calcaneus and navicular, using this position

bones so that it is not clearly shown. This angle is easily obtained by making a wooden angle board for insertion under the sole of the foot. The resultant film (Fig. 2) is quite different from that obtained by allowing the foot to remain flat and only tilting the tube.

This position is of particular value in the demonstration of coalition of the calcaneus and navicular, as described by Badgley<sup>1</sup> (Fig. 3). This should be looked for partic-

<sup>1</sup>Badgley, C. E. Coalition of the Calcaneus and the Navicular Arch Surg, July, 1927, XV, 75



Fig. 4. Roentgenogram showing exact joint surfaces involved in infection of the tarsal and metatarso-tarsal articulations, using this position.

ularly in cases of rigid pes planus, with peroneal spasm.

A lateral view of the external cuneiform without the superimposition of other bones is accomplished quite effectively. The middle cuneiform is less easily demonstrated in the lateral or oblique positions, but can be shown in the dorso-plantar position. The cuboid and navicular are also seen to good advantage. The metatarsal bones and the phalanges are shown obliquely, which is of considerable value in cases of suspected fracture. The talus and calcaneus are not clearly demonstrated by this position.

In cases of infection of the tarsal and metatarso-tarsal articulations, this position has been found to be of great value in determining the exact joint surfaces involved in the process (Fig. 4).

In conclusion, we believe this to be a good position for demonstrating most lesions of the fore-foot, particularly in cases in which we suspect coalition of the calcaneus and the navicular bones or pathology in the external cuneiform.

## REPORT OF TWO CASES OF OSTEOGENIC SARCOMA, POSSIBLY TRAUMATIC IN ORIGIN<sup>1</sup>

By BYRON H. JACKSON, M.D.  
SCRANTON, PENNSYLVANIA

Case 1. A. F., white, male, German, age 25, by occupation a mine laborer, was admitted to the Moses Taylor Hospital on October 4, 1930. He had been injured August 4, 1930, when he slipped on a piece of sheet iron in the mines, and fell across a railroad rail. He struck both femurs just above the knees, and received contusions over the inside of the right and outside of the left femur, two inches above the knee. He was treated by his physician for contusions for a short time, when the right leg, which was injured on the inside, was completely restored. The patient still complained of slight continual pain in the outside of the left leg, one inch above the knee. Nothing could be felt on examination. X-

<sup>1</sup>Reported before the November meeting of the Philadelphia Roentgen Ray Society, Philadelphia, Pa.



Figs 1 and 2 Case 1. X-ray examination, made two months from the date of injury, disclosed a periosteal osteogenic sarcoma, and exhibited destruction of the cortex, invasion of the shaft, bony spicules within the soft tumor, and some elevation of the periosteum

ray examination, made October 4, 1930, two months from the date of injury, disclosed a periosteal osteogenic sarcoma, and exhibited destruction of the cortex, invasion of the shaft, bony spicules within the soft tumor, and some elevation of the periosteum (Figs. 1 and 2). Amputation was refused, and X-radiation is being tried.

This case illustrates a definite trauma at the site of a malignant lesion in a patient who had previously exhibited no evidence of the disease.

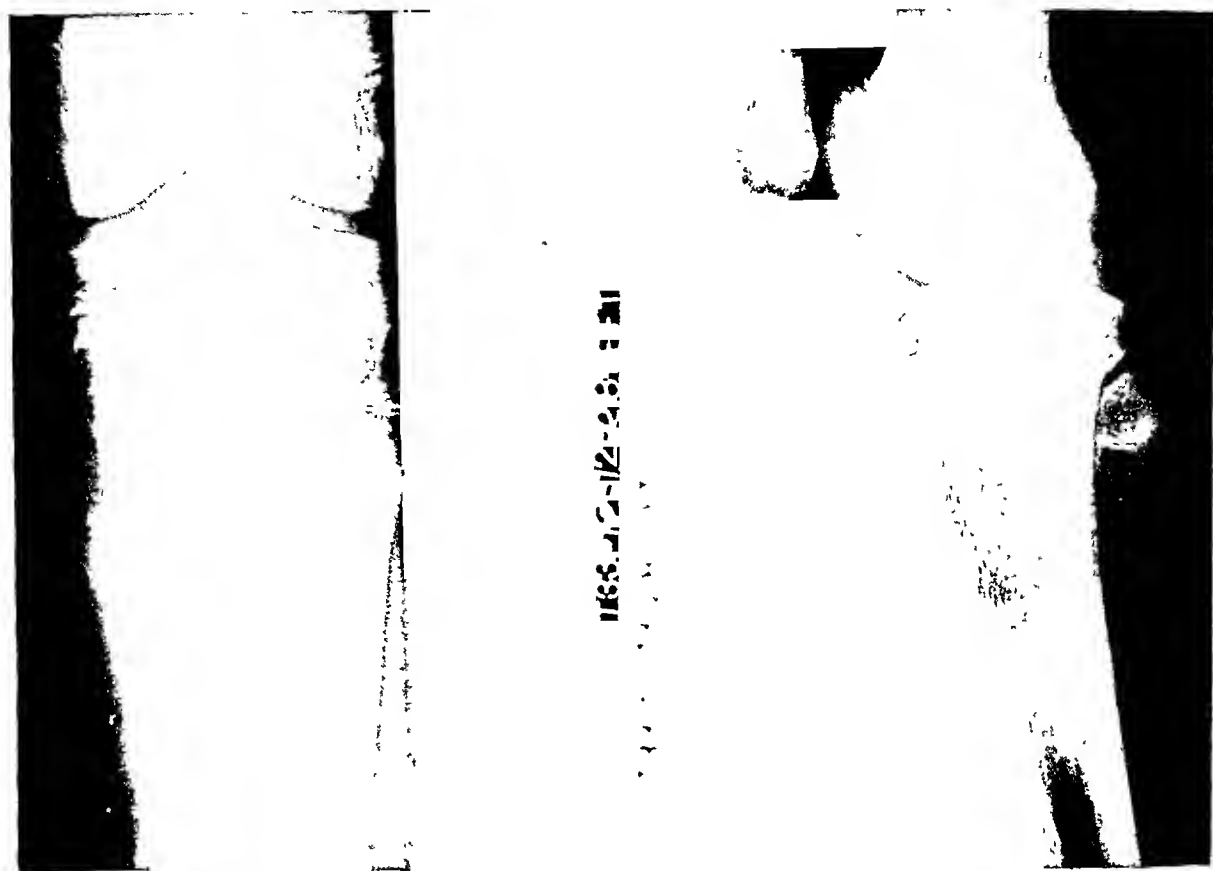
Case 2. H. L., aged 13, white, male, came to the Out-patient Department December 8, 1928, complaining of pain in the left knee following an injury three weeks before.

This school boy gave the following history: While playing at school three weeks previously, he had bumped his left leg

against a fire hydrant. He had not been to school since, but had not been confined to bed.

The left knee joint is apparently normal. Flexion is complete. The patella is freely movable. There are no signs of fluid in the knee, which is exactly the same in size as its fellow. The upper part of the left leg shows a diffuse fusiform swelling, more marked over the inner surface of the tibia. This swelling extends for about  $3\frac{1}{2}$  inches in the long diameter of the leg. The skin is slightly tense, not reddened. The swelling is definitely tender, slightly boggy; no fluctuation is felt, nor egg-shell crackle. The impression is that the bone itself is definitely injured and also that there is considerable swelling and edema in the soft parts. The temperature of the skin over the swelling is apparently higher than on





Figs. 3 and 4. Case 2. We have here a tumor involving the bone and soft tissues of the left tibia, upper, inner border. The tumor of the bone is nearly as wide as it is long. The cortex and shaft are destroyed. There is apparently no attempt at bone repair. There is some evidence of new bone within the soft tumor, with ossifying periostitis below the tumor.

the opposite side. The veins over the tumor are slightly more prominent. The ankle is normal. There is no pretibial edema below the tumor. There are definitely enlarged glands in the left groin and also in the left popliteal space. The glands in the right groin are also palpable, but not nearly so much so. Nothing can be felt in the abdomen.

*X-ray Examination.*—Films were taken December 8th, of the left tibia and fibula and knee, the right tibia and fibula (for comparison), and the lungs.

*X-ray Diagnosis.*—We have here a tumor involving the bone and soft tissues of the left tibia, upper, inner border. The tumor of the bone is nearly as wide as it is long. The cortex and shaft are destroyed. There is apparently no attempt at bone repair. There

is some evidence of new bone within the soft tumor, with ossifying periostitis below the tumor. A diagnosis of osteogenic sarcoma is made (Figs. 3 and 4). The lungs show no metastasis.

*Operation.*—At operation, December 17, 1928, under ether anesthesia, the swelling is found to be definitely larger than it was when the patient was examined four days before. The skin is not reddened nor tense, and not adherent to the tumor. There is, however, definite fluctuation. The tumor, especially over the inner surface of the head of the bone where it makes its most prominent salient, is very tender. The inguinal glands have not increased in size since December 13th. An incision about four inches long is made over the inner surface of the head of the tibia. There is some free blood

and edematous tissue present under the skin, which has given the impression of fluctuation. There is no pus. Practically the entire inner surface of the head of the tibia is broken down and can be wiped away with a sponge, without needing any bone-cutting instrument. This exposes a large cavity involving the entire head of the tibia. There is a moderate amount of apparently necrotic cancellous tissue, and clotted blood lying in this cavity, but no definite evidence of new growing bone tissue and no evidence of neoplasm. The walls of the cavity are ragged, irregular, trabeculated, having no smooth lining membrane. The impression, when this tissue is exposed, is that this is a bone cyst which has been broken by trauma and has very extensively degenerated since the trauma. Gross evidence is against pus or neoplasm. The cavity is curetted with the electric cautery and packed with iodoform gauze. Several irregular fragments of necrotic bone have been removed for microscopic examination, some of them to be sent to Dr. Joseph C. Bloodgood. An incision is then made over the most apparent gland in the groin and this removed. It is a flattened gland about  $\frac{1}{4}$  inch thick and  $1\frac{1}{4}$  inch in diameter. The cut surface presents a dull grayish appearance involving about one-half of the central portion. This gland is somewhat suggestive of neoplasm, but is not definite and does not give valuable

information until microscopic examination is made.

*Microscopic Examination by Dr. J. M. Wainwright.*—Gland, inflammatory. Osteogenic sarcoma of tibia.

*Microscopic Examination by Dr. J. C. Bloodgood.*—Osteogenic sarcoma of the upper end of the tibia shaft.

*Diagnosis.*—Bone tumor (periosteal sarcoma), osteogenic sarcoma—destructive type, giving an X-ray picture like bone cyst, upper end of the tibia. The following is an extract from a letter from Dr. Bloodgood: "This is a condition I have never seen before, a trauma changing the X-ray picture of a latent bone cyst. I trust you will report this case."

*Treatment.*—A radium pack was inserted within the cavity, which showed no tendency to granulate. The knee became fixed in a flexed position, with resultant atrophy of the leg and thigh. Later a mid-thigh amputation was done. The patient is now the picture of health. He has an artificial limb, has doubled his weight, and appears to be cured. Since there was no evidence of a bone lesion of any kind before the injury, it seems fair to presume that trauma may have been the causative factor. The contention that a bone cyst might have become malignant does not seem to be borne out by the fact that no lining membrane was found in this bone cavity.

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# EDITORIAL

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M. J. HUBENY, M.D. . . . . Editor

BENJAMIN H. ORNDOFF, M.D. . Associate Editor

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## IRRADIATION AND PREGNANCY

The question, "Does maternal pelvic radium or roentgen irradiation injure the health or development of the next generation?" has been asked frequently ever since it was discovered that such treatment could modify ovarian function. If irradiation could produce temporary sterility, the ova to be cast off subsequently might have been permanently damaged. Fertilization of these ova might give rise to the birth of unhealthy or defective children. Furthermore, early experiments indicated that embryonic tissues were peculiarly sensitive to irradiation. This latter fact suggested that serious damage might result from the use of irradiation in the treatment of pelvic diseases in women who might be pregnant at the same time.

The necessity for an investigation in this field became increasingly evident as reports dealing with unhealthy or defective children, whose mothers had received pelvic irradiation, began to appear in the literature. Furthermore, with an increasingly widespread use of radium and roentgen therapy, more women in the childbearing age were being treated with substerilizing exposures. A definite knowledge of the possible relationship between maternal treatment and injury to the child's health could be gained only through a detailed process of research. Accordingly, this study was begun in the manner to be outlined.

As much clinical material as possible was collected. The literature was searched for all case reports bearing upon the subject. Unpublished observations were solicited by means of more than seventeen hundred letters sent to leading gynecologists and radiologists in this country and abroad. These data were then analyzed in order to discover the birth-frequency of unhealthy children. The information contained in these case reports was tabulated. Where important facts were missing, this point was noted. A personal letter was then sent to each observer of an undeveloped or unhealthy child. Information upon the missing points was requested, as well as the latest information regarding the health of the child. In addition to the case reports received from the above sources, some personal observations of the author were included.

The study was concerned with the health of children born after the use of therapeutic amounts of treatment. The influence of diagnostic exposures, either before or after conception, was not investigated. One observer described a child who had been exposed early in its embryonic life to some very short roentgen exposures, used for diagnostic purposes, the mother being under observation for a ureteral or bladder stone. The child was pictured as being a "cross between a Mongolian idiot and a cretin." Since this is the only record dealing with diagnostic amounts of exposure and the birth of a defective child, with the knowledge at hand there is every reason to believe that diagnostic irradiation during pregnancy is harmless.

The reports which dealt with therapeutic degrees of exposure are best viewed in two groups: those which concern children ir-

radiated *in utero* and those which describe children conceived after the maternal treatment had taken place.

A critical study of the records of the children conceived *after* maternal treatment led to the conclusion that such children were unharmed. Clinical evidence and most experimental evidence agree on this point.

Irradiation of the fetus *in utero*, however, gave a different picture. Nearly one-third of a group of 76 full-term fetuses, so exposed, exhibited a serious degree of developmental retardation. Most of these individuals were microcephalic, although other mental and physical defects were observed. The great frequency of underdevelopment and the uniformity of the lesions suggested most strongly that they had a common cause.

The reasons for the fetal irradiation were numerous. In some cases pregnancy had been considered no contra-indication to treatment. In others, the possible danger of the treatment had been overlooked, or the health of the future child had been entirely disregarded in the interest of the mother. However, in most instances the fetal irradiation had been purely accidental.

In fourteen cases pregnancy took place between treatments in a series of roentgen therapeutic exposures, the ensuing amenorrhea being attributed to the treatment. Here, at a very early age, the embryo was subjected to the full force of the remaining exposures, which were insufficient to produce death or abortion.

One convincing personal observation was as follows: A healthy mother gave birth to three healthy children. The fourth pregnancy was complicated by early uterine hemorrhage, for which a long series of roentgen exposures was given. It was believed at the time that the bleeding was due solely to a submucous myoma. In this case no curettage was carried out preliminary to the use of the irradiation. The child, now

five years of age, is microcephalic, with a mental age of little more than two years. Two years after the birth of this child a fifth child was born, who is normal in every respect.

These observations have led to the following conclusions: Pre-conception maternal pelvic therapeutic radium or roentgen irradiation is in no way harmful to the health or development of any subsequent child. This evidence seems to be clear-cut and without exception. During pregnancy diagnostic roentgen irradiation is a safe procedure. However, it would seem wise to delay its use as long as possible, and to use the minimum amount of exposure, especially in the very early months of pregnancy. On the other hand, therapeutic pelvic irradiation during pregnancy is extremely likely to injure the fetus. A preliminary curettage should precede the use of radium or roentgen treatments in women of the child-bearing age. By so doing, no unsuspected embryo would be irradiated unwittingly. Every precaution should be taken to make sure that no patient becomes pregnant between any two treatments in a series. Should a fetus become exposed to large amounts of irradiation, the pregnancy should be terminated before the period of viability, whenever possible. Should it become necessary to apply therapeutic pelvic irradiation early in pregnancy, the uterus should be emptied. If the pregnancy is advanced, an induction of premature labor should precede the treatment.

DOUGLAS P. MURPHY, M.D.

Philadelphia.

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## A NEW SCREEN

Our readers' attention is called to the announcement by The Patterson Screen Company of a new and faster intensifying screen, known as the Patterson Speed Combination. These screens are used in pairs.

one thin front screen and one thick back screen. By reducing the thickness of the front screen its absorption is reduced, thus permitting more of the X-radiation to act on the film direct and to excite the thick back screen. The manufacturer reports that this new Speed Combination retains all of the well-known qualities of the Patterson Cleanable intensifying screen, namely, freedom from grain, freedom from afterglow or lag, with good contrast, plus the added advantage of more speed.

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### THE INDIANA ROENTGEN SOCIETY

The Indiana Roentgen Society held its fourth annual meeting in Indianapolis on February 21st. E. L. Jenkinson, M.D., of Chicago, was the speaker. The following officers were elected: *President-elect*, L. F. Fisher, M.D., of South Bend; *Vice-president*, H. C. Bernheimer, M.D., of Terre Haute; *Secretary-Treasurer*, J. N. Collins, M.D., of Indianapolis.

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### PROGRAM OF THE THIRD CONGRESS OF THE PAN-AMERICAN MEDICAL ASSOCIATION AT THE CITY OF MEXICO

Sunday, July 26, 1931, 8:00 P. M.: Inaugural session, attended by the Honorable President of the Republic at the Bolivar Hall of the National Preparatory School.

Monday, July 27, 9:00 A. M.: Practical demonstrations in medicine and surgery in several hospitals and laboratories.

3:00 P. M.: Sessions of different Sections.

7:00 P. M.: Reception at Chapultepec Castle by the Honorable President of the Republic.

Tuesday, July 28, 9:00 A. M.: Practical demonstrations in medicine and surgery in several hospitals and laboratories.

1:00 P. M.: Lunch under the auspices of the Organization Committee at the National Preparatory School.

3:30 P. M.: Sessions of different Sections.

9:00 P. M.: Concert at the Hall of the National Preparatory School.

Wednesday, July 29, 9:00 A. M.: Visit to several branches of the Department of Public Health.

1:00 P. M.: Lunch under the auspices of the Department of Public Education.

3:30 P. M.: Sessions of different Sections.

8:00 P. M.: General Session at the National Academy of Medicine in honor of foreign delegates.

Thursday, July 30, 9:00 A. M.: Sessions of different Sections.

10:00 P. M.: Ball offered by the Department of Public Health.

Friday, July 31, 10:00 A. M.: Meeting of the Committee on Resolutions.

8:00 P. M.: Final general sessions.

A Scientific and Commercial Exposition will take place near the hall where the Sessions are to be held.

For the convenience of those attending the meeting special excursion rates have been arranged with the steamship lines and by railroads. From the Atlantic coast, *via* New York, by the Ward Line: Rate to Mexico City and return, first class, including railroad trip from Vera Cruz to Mexico City, \$150.00. From Havana, \$115.00.

Information may be obtained from any one of the following:

Dr. Francisco de P. Miranda, Executive Secretary of the Congress, Departamento de Salubridad, Mexico City.

Dr. Conrad Berens, Treasurer of the

Pan-American Medical Association, 35 East 70th St., New York City.

Dr. J. E. Lopez Silvero, Executive Secretary of the Association, Secretaria de Sanidad. Havana, Cuba.

## BOOK REVIEWS

**PRACTICAL RADIATION THERAPY.** By IRA I. KAPLAN, B.S., M.D., Director Division of Cancer, Department of Hospitals, New York City; Attending Radiation Therapist, Bellevue Hospital; Lecturer in Radiation Therapy, New York University and Bellevue Hospital Medical College; Director, New York City Cancer Institute, with a special chapter on Applied X-ray Physics by CARL B. BRAESTRUP, B.Sc., P.E., Radiation Physicist, Division of Cancer, Department of Hospitals, New York City; Physicist to Mt. Sinai Hospital, New York City. Illustrated; 354 pages. W. B. Saunders Company, Philadelphia, 1931. Price \$6.00.

This volume is a welcome addition to the sparse supply of available texts on radiotherapy, and is, in fact, the only book on the subject. For the teacher of radiation therapy this book will be a ready reference for "collateral reading." For the student it will be a welcome addition to lecture notes, as it makes available in brief yet more than elementary form the practical aspects of the specialty, omitting many theoretical as well as controversial problems. The non-mathematical or non-physical reader will be favorably impressed by the almost total lack of curves and tables. Throughout, the subject of radiotherapy is presented from the point of view of the clinician, treating patients in his every-day practice.

In X-ray therapy the author uses a cross-fire method with repeated divided doses; in radium therapy small doses, heavily filtered, are applied over a long period of time. Such

technics as are described in the text will serve as a basis for modifications according to one's experience.

**CANCER: ITS ORIGIN, ITS DEVELOPMENT AND ITS SELF-PERPETUATION: THE THERAPY OF OPERABLE AND INOPERABLE CANCER IN THE LIGHT OF A SYSTEMIC CONCEPTION OF MALIGNANCY. A RESEARCH.** By WILLY MEYER, M.D. Consulting Surgeon to the Lenox Hill and Post-graduate Hospitals. Pp. 427, with illustrations. Cloth. Price, \$7.50. Paul B. Hoeber, Inc., New York, 1931.

This book, based on the author's exhaustive study of the literature since 1917, deals with malignant tumors as an ordinary lawful reaction of tissue to certain systemic and local morbid conditions of the human body; it denies the autonomy of cancer; it asserts the probable unity in character of all types of newgrowths; it recognizes chronic irritation coupled with a predisposition to cancer as the probable cause of all types of tumors, and it holds that persons with a degree of alkalinity of their body fluids higher than normal are predisposed to cancer, those with an acidosis probably being immune to it.

The author states that both the stage of mere presence of cancer susceptibility before there is any local irritation, and the stage of mere presence of local chronic irritation before the patient has, by trauma, acquired a susceptibility, are amenable to prophylaxis by suitable medical means. The stage of active tumor should be treated by a simultaneous attack on both chronic irritations by a correctly selected combination of surgery and medication.

Such a thesis as this, which presents cancer from a quite different angle, deserves serious study and consideration.

# ABSTRACTS OF CURRENT LITERATURE

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CHEMICAL<sup>1</sup>

An X-ray Investigation of the Crystals of Azobenzene. Mata Prasad. *Phil. Mag.* [7], 1930, X, 306.

Crystals obtained by slow evaporation from alcohol belong to the monoclinic prismatic class with the lattice constants  $a = 12.65$  A.U.,  $b = 6.06$ ,  $c = 15.60$ ,  $\beta = 114^\circ 24'$ , and with the axial ratios  $a:b:c = 2.087:1:2.574$ . The space group is  $C_{2h}^2$  and requires 4 molecules per unit cell. A remarkable feature is a nearly complete symmetry about the  $(20\bar{1})$  plane, both in respect to geometrical relations and to intensities of reflection by corresponding planes.

## CHEMICAL ABSTRACTS.

The Influence of Chemical State on Critical X-ray Absorption Frequencies. H. R. Robinson and C. L. Young. *Phil. Mag.* [7], 1930, X, 71 (cf. *Chem. Abs.*, XVIII, 623).

By an improved satisfactory technic the  $K$  levels of Cr in metal and in hydroxide were measured. For Cr metal  $\tau/R = 440.99$ , agreeing with Lindh's value.  $\Delta\tau/R$  for Cr  $(OH)_2$  and Cr  $K$  levels was found to be  $0.5 \pm 0.15$  Rydberg unit, which is only one-half of Lindh's value. The discrepancy is not due to a dehydration effect.

## CHEMICAL ABSTRACTS.

Quantitative Spectroscopic Analysis with Secondary X-rays. G. v. Hevesy, J. Böhm, and A. Faessler. *Ztschr. f. Physik*, 1930, LXIII, 74.

X-rays, coming from the suitably excited substance, whose composition has to be determined, are analyzed spectroscopically. From the intensities of the emission lines (e.g.,  $K_\alpha$ ) compared with those from a suitable element added to the sample in known quantity, the concentration of the former may be obtained. It has been found that it is necessary to use secondary X-rays to excite the compound to be analyzed, because the ordinary electron impact alters the composition by selective evaporation. The X-ray tube consists of a glowing cathode surrounded by a cylinder with a

little carrier which contains the compound to be analyzed and is placed at a short distance from the anticathode supplying the primary X-rays. The intensity of current through the X-ray tube may be considerable (20 ma.), as the ray coming from the cathode must not be centered. A maximum intensity is obtained, when the primary  $K_\alpha$  radiation of the anticathode is about 200 X.U. harder than the  $K$  absorption edge of the secondary radiator, the continuous spectrum contributing but little to the total radiation. The yield of secondary radiation increases considerably for a given input when the tension is raised; therefore it is advisable to run the X-ray tube with low intensity of current. The intensity of lines, whose potential of excitation does not differ more than 250 X.U., is independent of the tension applied to the tube. The time of exposure was generally 2 to 3 hours, the precision of estimation 0.01, if the element was present in a concentration of 1 per cent. The various sources of error are discussed and a list of elements of reference is given.

## CHEMICAL ABSTRACTS.

The Crystalline Structure of Rubidium Azide. Linus Pauling. *Ztschr. f. phys. Chem.*, 1930, Abt. B, VIII, 326.

Polemical. The structure proposed by Günther and co-workers (*Chem. Abs.*, XXIV, 2930) for Rb azide is inconsistent with the known values of atom radii. A structure similar to that of K azide is to be preferred. (*Reply*: P. Günther and P. Rosbaud. *Ibid*, 329.)

## CHEMICAL ABSTRACTS.

X-ray Intensity Measurements with Deformed Crystals. J. Hengstenberg and H. Mark. *Ztschr. f. Physik*, 1930, LXI, 435 (cf. *Chem. Abs.*, XXIV, 3947).

The application of X-ray intensity measurements to the study of small changes in structure due to mechanical, chemical, thermal, and electrical influences is discussed. Reflections from the cubic faces of sylvine during distortion were obtained with an ionization spectrometer. The increase in (200) and (400) reflections with distortion is due to an increase

<sup>1</sup>Reprinted by permission from *Chemical Abstracts*.

in mosaic-like structure, while diminution in (600), (800), and (1000) reflections is due to deformation of the grating elements. Measurements of line width show disturbances at the slip planes to be local; a 3.8 per cent compression disturbs 2.25 per cent of the atoms with a maximum amplitude  $\frac{1}{8}$  of the atomic spacing.

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CHEMICAL ABSTRACTS.

Intensity Measurements of Diffuse X-rays Reflected from Distorted Sylvine. R. Brill. *Ztschr. f. Physik*, 1930, LXI, 454.

An apparatus for X-ray measurements, using the Geiger counter method, is described. Measurements show an increase in intensity of diffuse radiation, with deformation of the crystal.

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CHEMICAL ABSTRACTS.

New Investigation on the Blue-gray Bright Spot Radiation of the Lilienfeld-Röntgen Tubes. Franz Rother and Willi M. Cohn. *Physik. Ztschr.*, 1930, XXXI, 687.

Visible radiation from Lilienfeld tubes has been studied from 520 to 225 m $\mu$ . An intensity maximum occurs at 450 m $\mu$ . The radiation could not be resolved into lines or bands and probably extends far into the ultra-violet. The limits and intensity distribution in the continuous spectrum are unchanged with different anticathode materials.

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CHEMICAL ABSTRACTS.

Difference in the Intensities of X-ray Reflection from the Two Sides of the III Plane of Zinc Blende. D. Coster, K. S. Knol, and J. A. Prins. *Ztschr. f. Physik*, 1930, LXIII, 345.

The authors investigate the phase jumps of X-rays of wave length immediately on either side of the *K* absorption edge of Zn in ZnS. The large ratio of the absorption coefficient for the two wave lengths (1.20) occasions a phase displacement of the order of 10°. The observation is rendered possible by the fact that the Zn (111) plane divides the distance between two neighboring S (111) planes in the ratio of 1 to 3. Phase differences of 80° and 110° for first order and 280° and 260° for

third order are obtained on opposite sides of the crystal planes between Zn and S components of the diffraction spectra. The resultant difference in intensity is observed experimentally by the use of the Au *L* and W *L* lines.

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CHEMICAL ABSTRACTS.

New X-ray Spectrograph with Absolute Zero Determination without a Divided Circle and the Zero Method of Cornu. H. Seemann. *Ztschr. f. Physik*, 1930, LXI, 416.

A new X-ray spectrograph is described. The method at present almost universally used for the determination of the zero point with the Bragg spectrograph is that due to Cornu (1880). An arrangement is shown for the determination of the zero point by this method, using a pin-hole camera, and the new spectrograph employs a pin-hole camera, but has a new method for determining the zero point. The crystal is mounted on a table on a rod which can rotate through 180° about a vertical axis with accuracy, obviating the use of a divided circle. The rotation can take place in either direction, and the table is accurately fixed in position by contact screws. The principle of the method and the sources of error are discussed.

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CHEMICAL ABSTRACTS.

The Determination of the Inner Structure of Liquids by X-ray Means. P. Debye and H. Menke. *Physik. Ztschr.*, 1930, XXXI, 797.

The general method adopted is to start with the experimental results and work toward the structure rather than to assume a structure and derive the theoretical result. Because it is monatomic, liquid Hg was used for the experimental work, and, to simplify the absorption correction, the method of surface reflection was used. The intensity of reflection from a volume of *N* atoms, if there be no interference between scattered rays, is given by:

$$I = \frac{1 + \cos^2 \theta}{2} N \psi^2, \text{ where } \psi^2 \text{ is a function of } \theta,$$

the angle between the primary and secondary beams, which characterizes the scattering from single atoms (*i.e.*, the so-called atom-factor). The observed results do not agree

with this expression, but may be expressed by  $I = \frac{1 - \cos^2 \theta}{2} \lambda^3 E(s)$ , where  $s = 2 \sin \theta/2$  and  $E(s)$  is a purely experimentally determined function of  $s$ . The experimental  $E(s)$  vs.  $s$  curve has the form of a damped vibration curve above and below the value  $E(s) = 1$ , which is approached at high values of  $s$ . If  $H^*$  be taken as the probability that the second of two atoms will lie in a volume  $dV$ , distant  $r$  from the first atom, it can be shown that:  $s [1 - E(s)] = \frac{2\lambda^3}{d^3} \int_0^a p [1 - H^*(p)] \sin 2\pi \text{ spdp}$ . Here the variable is not  $r$  but  $p = \frac{r}{\lambda}$  where  $\lambda$  is the wave length.  $d$  is defined by  $\lambda d^3 = V$ , where  $V$  is the whole volume under consideration.  $H^*$  is not known as a function of  $p$ , but, instead,  $E(s)$  is known as a function of  $s$ . By the methods of Fourier, there results  $p [1 - H^*(p)] = \frac{2d^3}{\lambda^3} \int_0^a s [1 - E(s)] \sin \pi p s ds$ . The integration may be performed by using the experimental relation between  $E(s)$  and  $s$ . The problem worked out for Hg shows that certain distances, i.e., 3, 5.6, and 8.1 Å.U., are the most probable distances between atoms. Thus a quasi-crystal structure is present even in a liquid.

CHEMICAL ABSTRACTS.

An X-ray Analysis of the Copper-manganese Alloys. Elis Persson. Ztschr. f. phys. Chem., 1930, Abt. B, IX, 25.

An X-ray crystallographic analysis of the Cu-Mn system is reported and the possibility discussed of a continuous transition of the Cu-phase into the  $\gamma$ -Mn-phase, with increasing Mn content. It is shown that the  $\gamma$ -Mn-phase, ordinarily stable at high temperatures only, becomes stable at ordinary temperatures when alloyed with small quantities of Cu and chilled. The boundary of this phase occurs with concentrations of 83 atomic per cent Mn. The lattice parameter of the Cu-phase increases with increasing Mn content, from 3.008 to 3.74 Å.U. with 50 per cent Mn, then remains constant to the phase boundary. The atomic

volume in both simply built phases appears to change continuously over the entire system. Alloys consisting of these phases are formed with considerable expansion

CHEMICAL ABSTRACTS.

Investigation of Gold-copper Alloys by Means of X-rays. K. Ohshima and G. Sachs. Ztschr. f. Physik, 1930, LXIII, 210.

Above 400° an alloy of Au + Cu crystallizes in the cubic face-centered system (lattice construction  $a = 3.866$  Å.U.). Below 400° a tetragonal lattice of AuCu ( $a = 3.95$ ,  $c = 3.68$  Å.U.) and a cubic face-centered lattice of AuCu<sub>3</sub> occurs. The influence of heating and cooling on the structure is studied by means of rotation and Debye-Scherrer diagrams.

CHEMICAL ABSTRACTS.

Calculation of the X-ray Terms of the Lighter Elements and the Rare Gases from the Optical Potential of Ionization. Werner Braunbek. Ztschr. f. Physik, 1930, LXIII, 154; 718.

The potentials of excitation of  $K_{\alpha}$  of Li, Be, B, and C are obtained from the ionization potentials of Li<sup>+</sup>, Be<sup>++</sup>, B<sup>+++</sup>, C<sup>++++</sup>, by taking account of the screening effect of the outer electrons on an electrostatic basis (under very simplifying assumptions). For the heavier rare gases Ne, Ar, Kr, and Xe the effect of the outer electrons is obtained from the screening number of Sommerfeld's theory of the relativistic doublets.

CHEMICAL ABSTRACTS.

The Lattice Constants of the Elements. William Hume-Rothery. Phil. Mag. [7], 1930, X, 217.

An examination of the measured lattice constants reveals a law of sub-groups which states that in any sub-group of the periodic table, provided that the co-ordination number remains constant, the interatomic distance  $d$  is given by the relation  $d/n = (1/aZ)^x$ , where  $n$  is the principal quantum number of the outermost shell of electrons remaining attached to the ions,  $Z$  is the atomic number,  $x$

is a constant which is the same for groups with the same number of electrons in the outermost shell, and  $a$  is a second constant which in some groups may be connected with the valency. The table gives the values of  $a$  and  $x$ .

| Group | Elements           | $a$     | $x$   |
|-------|--------------------|---------|-------|
| IA    | Li, Na, K, Rb, Cs  | 0.0157  | 0.344 |
| IIA   | Be, Mg, Ca, Sr, Ba | 0.02265 | 0.35  |
| IVA   | C, Si, Ti, Zr, Hf  | 0.0465  | 0.345 |
| VA    | V, Ta              | 0.0628  | 0.368 |
| VIA   | Cr, Mo, W          | 0.0675  | 0.376 |
| VIIIA | Fe, Ru, Os         | 0.05998 | 0.404 |
| VIIIB | Co, Rh, Ir         | 0.05689 | 0.418 |
| VIIIC | Ni, Pd, Pt         | 0.05808 | 0.39  |
| IB    | Cu, Ag, Au         | 0.05105 | 0.393 |
| IVB   | Ge, Sn             | 0.0588  | 0.33  |
| VB    | As, Sb, Bi         | 0.04753 | 0.323 |
| VIB   | Se, Te             | 0.0944  | 0.21  |
| O     | Kr, Xe             | 0.02735 | 0.348 |

In some cases the error in the calculated value is 1 per cent but usually the calculated value is in much closer agreement with the determined. The value of  $x$  reaches a maximum in Group VIII B. The value of  $a$  is not strictly proportional to the valency. The change in co-ordination number does not cause the same percentage change in the different groups; in Group IV its effect is comparatively slight. In the first short period the interatomic distance  $d$  is inversely proportional to the atomic number  $Z$ ; in the second period,  $d$  is inversely proportional to  $Z^2$ ; in the third group, to  $Z^3$ ; in the fourth group, almost to  $Z^5$ . The interatomic distance for Al does not fit into the scheme, indicating that it is probably not fully ionized in the metallic crystal.

#### CHEMICAL ABSTRACTS.

**The Total Reflection of X-rays.** Erich Nähring. *Physik. Ztschr.*, 1930, XXXI, 799.

The formula given below is derived:

$R = \frac{1 - aq + a^2/2}{1 + aq + a^2/2}$ , where  $R$  is the ratio of the reflected to the incident intensity.

$a^2/2 = q^2 - 1 + \sqrt{(q^2 - 1)^2 + k^2}$ ,  $q = \frac{\theta}{\theta_0}$ ,

$= \frac{\theta}{\sqrt{2\delta}}$ ,  $\theta$  being the angle of incidence and  $\delta$

the deviation of the index of refraction from 1,  $k = x/\delta$ ,  $x$  being given by  $n = (1 - \delta) - ix$ .

The formula has been verified with experi-

ments in which X-rays between  $\lambda = 1.242$  Å.U. and  $\lambda = 2.358$  Å.U. were reflected from Ag. The verification was made indirectly,  $\delta$  being calculated by the Drude-Lorenz formula. It is pointed out that the formula may be used to determine the index of refraction for long X-ray wave lengths.

#### CHEMICAL ABSTRACTS.

**Contribution to the Knowledge of the K X-ray Absorption Spectrum of Nickel, Copper, and Zinc.** Axel E. Lindh. *Ztschr. f. Physik*, 1930, LXIII, 106.

The wave lengths of the absorption edges of Ni, Cu, and Zn depend on the chemical state of the elements; the frequency shift amounts for  $\text{ZnSO}_4$  to 6 v.; for  $\text{ZnS}$  to 3 v.; for  $\text{ZnK}_2(\text{SO}_4)$  to 6 v. For Ni and Cu the absorption edge is double and possesses fine structure. Apparatus: Siegbahn vacuum spectrograph, calc spar crystal.

#### CHEMICAL ABSTRACTS.

**Determination of the Degree of Polymerization of Some Modifications of Polyoxymethylene by Means of X-ray Methods.** Emil Ott. *Ztschr. f. phys. Chem.*, 1930, Abt. B, IX, 378 (cf. *Chem. Abs.*, XXIV, 3147).

The method is the same as that used in the previous paper. A high accuracy is claimed. Paraformaldehyde consists of 32 formaldehyde groups,  $\gamma$ -polyoxymethylene of 60 groups, and  $\delta$ -polyoxymethylene of 24. The length of a formaldehyde group is 1.88 to 1.89 Å.U. It is shown that in highly polymerized substances molecules of equal length form the crystals.

#### CHEMICAL ABSTRACTS.

**A Classification System of the Silicates Based upon Crystal Structure.** St. v. Náray-Szabó. *Ztschr. f. phys. Chem.*, 1930, Abt. B, IX, 356.

A new classification system of the silicates based upon their crystal structure is developed. It is based upon the various arrangements of the Si and O atoms. The principal

groups are: (1)  $(\text{SiO}_4)$  group, orthosilicates; (2) independent groups, with a greater content of Si (e.g.,  $\text{Si}_2\text{O}_7$ ); (3)  $\text{SiO}$  chains; (4)  $\text{SiO}$  planes, and (5) 3-dimensional  $\text{SiO}$  network lattices. A large number of the silicates are entered into this system in a set of tables. Some of the properties of the silicates are explained on the basis of their structure.

## CHEMICAL ABSTRACTS.

**The Reflection of X-rays on Absorbing Ideal Crystals.** J. A. Prins. *Ztschr. f. Physik*, 1930, LXIII, 477.

The dynamic theory of X-ray reflection (Ewald-Darwin) is extended to include absorption effects. It results that the intensity distribution inside a spectral line must be unsymmetrical with respect to the angle of regular Bragg reflection (corrected for the refractive index). The total intensity is also perceptibly influenced by absorption.

## CHEMICAL ABSTRACTS.

**X-ray Determination of the Solubility of Copper in Silver.** N. V. Ageev and G. Sachs. *Ztschr. f. Physik*, 1930, LXIII, 293.

The variations of the lattice dimensions of Ag containing Cu (less than necessary for the formation of mixed crystals) is used as a measure of the Cu content. To obtain reliable results, the surface of the material has to be perfect; this is best obtained by melting the alloy in a vacuum furnace. The solubilities of Cu in Ag at various temperatures are given.

## CHEMICAL ABSTRACTS.

**The Structure of Chromium Trichloride.** Nora Wooster. *Ztschr. f. Krist.*, 1930, LXXIV, 363 (in English).

$\text{CrCl}_3$  was obtained by sublimation in dry Cl at about  $1000^\circ$  in the form of extremely thin hexagonal plates, violet in color. It is optically negative and the Becke line (seen with great difficulty) suggests an index between 1.63 and 1.64. Specific gravity was de-

termined as 2.87, which is higher than the usual value (2.77). A combination of X-ray methods gave the following results: space group  $D_{3h}^3$ , or  $D_{3d}^3$ , unit cell contains 6 molecules;  $a = 6.02$  Å.U. and  $c = 17.3$  Å.U. These data differ from those of Natta (*Chem. Abs.*, XXI, 2406). The Cl atoms have a cubic close-packed arrangement, and each Cr atom is surrounded by 6 Cl.

## CHEMICAL ABSTRACTS.

**The Absorption of X-rays in Gases and Vapors: I.—Gases.** J. A. Crowther and L. H. H. Orton. *Phil. Mag.* [7], 1930, X, 329.

New measurements using Cu K radiation gave the following results:

|                                 | $u$   | $I_v$ | $I_m$ |
|---------------------------------|-------|-------|-------|
| Air .....                       | 9.46  | 1.000 | 1.000 |
| $\text{N}_2$ .....              | 7.43  | 0.743 | 0.766 |
| $\text{O}_2$ .....              | 11.14 | 1.438 | 1.301 |
| $\text{CO}_2$ .....             | 9.30  | 1.530 | 1.006 |
| $\text{CH}_2:\text{CH}_2$ ..... | 4.32  | 0.508 | 0.524 |
| $\text{H}_2\text{S}$ .....      | 82.7  | 14.96 | 12.58 |

$u$  = mass absorption coefficient.

$I_v$  = relative ionization for equal volumes.

$I_m$  = relative ionization for equal masses.

The fraction of absorbed X-ray energy utilized in producing ionization is approximately constant for the majority of gases except  $\text{N}_2$ , for which it is 15 per cent greater.

## CHEMICAL ABSTRACTS.

**The Action of X and Gamma Radiation upon Aqueous Solutions of Iodine and Potassium Iodide.** G. Harker. *Med. Jour. Australia*, Dec. 20, 1930, II, 817.

It is shown that Bordier's statement that iodine in aqueous solution disappears under the influence of X-rays is erroneous, his effect being due to the interaction between the iodine solution and the paraffin which he used to coat the cardboard box of his experiments. The radiation employed was derived from a Coolidge water-cooled therapy tube energized at 40 K.V. constant potential, and 2.5 ma. at 12 cm. target-object distance for



a period of one hour. No filtration is mentioned. Two tubes of iodine solution of concentration such that 3 c.c. reacted exactly with 0.20 c.c. N/500 sodium thiosulphate solution were exposed. One tube was shielded by lead (thickness not stated), the other with a sheet of black paper. At the end of one hour, each tube required 0.16 c.c. of N/500 sodium thiosulphate solution for exact reaction. That is to say that there was no difference between the irradiated and non-irradiated solutions. Starch iodine solution was also unaffected by X-rays in the above dosage. It is not made clear that thermal effects were entirely eliminated by the method of using the screened control—and temperature effects have been a fallacy in many biological experiments with X-rays.

The author mentions, however, that using 65 K.V. and 2.5 ma., the solution, "unprotected by lead, was exposed to a higher temperature, with a small increase in the loss of iodine caused by reaction with water." He does not show that the effects of X-rays and raised temperature are not antagonistic. More definite are the results with  $\gamma$ -rays, which also do not affect iodine solution (6 mg. needles filtered with 0.5 mm. of platinum for five days in a solution containing 0.126 gm. of iodine per liter).

Kailan's result that  $\gamma$ -rays decompose solutions of potassium iodide were confirmed, and shown to hold for X-rays also. Attention is drawn to the marked acceleration of the action of the rays produced by the addition of small amounts of acid.

J. G. STEPHENS, M.B. (Syd.), D.M.R.E.

### DOSAGE

Application and Dosage of Bucky's "Borderline Rays" in Ophthalmology. Ilona Krasso. *Strahlentherapie*, 1930, XXXVIII, 358.

The author studied the effect of X-rays of long wave length on the eyes of rabbits. He found that doses as high as 4,000 r produce only an injury to the cornea but do not affect the lens. He feels that the tolerance dose for borderline rays is about twice as high as for ordinary roentgen rays. His therapeutic stud-

ies on human eyes showed similar relations. From 50 to 200 r of a half value layer in aluminum equal to 0.02 mm. were given in the average case. The treatment can be repeated at intervals of from two to fourteen days, up to five times. Satisfactory results were obtained in the following diseases: erosio corneae; herpes corneae; keratitis filamentosa, dendritica and punctata superficialis; rosacea of the cornea, infiltrated erosions; superficial ulcer, episcleritis, and scleritis.

ERNST A. POHLE, M.D., Ph.D.

A Biologic Unit in the Dosage of Roentgen Rays. E. Björling. *Strahlentherapie*, 1930, XXXVI, 751.

This paper is based on the assumption that 1 r produces different biologic effects if different wave lengths are used. Measuring methods both for quality and quantity of roentgen rays have been worked out by the author, permitting the expression of the dose in "bio-r." This is the unit of his biologic measuring system which takes the wave length dependence into consideration. The details of the technical procedure and also its theoretical foundations must be looked up in the original.

ERNST A. POHLE, M.D., Ph.D.

Maximum Dose, Fractional Treatment, or Saturation Method? Studies on Mice with Carcinoma. Jens Juul. *Strahlentherapie*, 1930, XXXVIII, 623.

The author studied the effect of roentgen rays and radium applied according to the single massive-dose method, the fractional, and saturation-dose method on transplanted tumors in mice. The technic is as follows: 220 K.V., 2.8 ma., 5 mm. Al, 2.3 cm. F.S.D., 1 S-N. = 6 min.,  $3\frac{1}{2}$  S-N. equal to 1 E.D. The exposures were given as follows: 6 S-N. in one sitting,  $3 \times 2$  S-N. twice weekly,  $3 \times 2$  S-N. once every 2 weeks, and  $3 \times 2$  S-N. once every 3 weeks, or 6 S-N. in one sitting,  $3 \times 2$  S-N. applied twice daily and  $3 \times 2$  S-N. on three successive days. In both groups, the single-massive dose had the most pronounced effect. In observing the epilation following the treatment, it appeared, however, that 6 S-N. given in one sitting always epilated,

while  $3 \times 2$  S-N., applied every twelve hours, rarely did so. Another series received 6 S-N. in one sitting, 2 S-N. six times, applied twice weekly, and then 5 S-N. in one sitting followed by  $4 \times 2$  S-N., given once a week.

The results demonstrated that the dose on the skin could be higher with the protracted fractional method without causing injuries, and that the therapeutic effect on the tumor was better than that of a single-massive dose. Similar experiments carried out with radium lead to the conclusion that a more severe reaction follows the application of a high intensity in a short time than the application of a small intensity over a long period. Since the skin and tumor tissue apparently cumulate radiation in a different manner, the fractional dose method is advantageous. It permits the application of a higher total dose within the tumor without damaging the skin.

ERNST A. POHLE, M.D., Ph.D.

**Roentgen Dosage in Practice.** Th. C. Neff. *Strahlentherapie*. 1930, XXXVIII, 322.

The author visited fourteen Radiological Institutes in Germany, Austria, Switzerland, France, and Belgium, and had his ionization instrument calibrated in r-units. It appeared that the calibrations carried out in Germany differed as much as 16 per cent, while the highest variation among all calibrations amounted to 18 per cent. These discrepancies are high if one considers the fact that the measuring instruments available to-day are accurate within 1 per cent. The various precautions necessary to calibrating a dosimeter are discussed in detail; the conditions under which the measurements are carried out are often responsible for the differences in the results. Although the variations found do not interfere with the practical work, the investigator must demand a higher degree of accuracy. Steps are being taken by the Standardization Committee of the German Roentgen Ray Society to remedy the situation.

ERNST A. POHLE, M.D., Ph.D.

## GALL BLADDER (NORMAL AND PATHOLOGICAL)

**Intravenous Cholecystography and Liver Function Determination: Clinical and Roentgenological Value.** Sydney R. Miller and Charles A. Waters. *Southern Med. Jour.*, December, 1930, XXIII, 1079.

The authors add the weight of their experience to the intravenous method of administering the dye, and contend that it is essentially devoid of dangerous reactions, is not time-consuming or complicated, and is more dependable than the oral technic. This series includes cases with severe jaundice, due to cholangitis, common duct obstruction, and severe liver damage following arsphenamine treatment, without any unpleasant reactions. In using the intravenous technic as a liver function test, from 12 to 15 c.c. of blood are withdrawn one-half hour after the administration of the dye, and tested colorimetrically for the percentage of dye retained. The authors' series covers 131 patients, 24 of whom came up for operation. Of these 24, the operative findings agreed with the X-ray findings in 20 cases. Of the 107 patients not operated upon, the clinical symptoms and X-ray findings agreed in 95 cases, or 88 per cent.

The authors conclude that this series is but another confirmation of the extreme value of cholecystography as a method of detecting functional abnormalities, and hence, presumably, diseased conditions of the gall bladder. They contend that the failure of the gall bladder to visualize by the oral method must be checked by the intravenous route, particularly in cases in which the clinical picture is not a clear one of gall-bladder disease.

W. W. WATKINS, M.D.

**Gallstones in the Ampulla of Vater.** E. Starr Judd and James M. Marshall. *Jour. Am. Med. Assn.*, Oct. 11, 1930, XCV, 1061.

Fenger, many years ago, described the symptoms of stone lodged in the ampulla, the "ball-valve stone of Fenger." A series of 160 cases were reviewed in which one or more stones were found in the ampulla at operation, and in which the stones were not found in

the hepatic or common bile ducts. In 45 per cent of the series, one or more operations had been performed in the biliary system. In several cases, as many as three or four operations had been performed. Periods of relief varied. The most characteristic feature of stone in the common bile duct is the intermittent nature of the symptoms. Osler stressed paroxysms of colicky pain, chills and fever, and jaundice, followed by intervals of comparative or complete freedom from symptoms—or classic symptoms. Duodenal drainage affords a valuable clue as to whether or not bile is passing from the duct into the duodenum. The technic of operation is discussed and some interesting observations at operation review the occurrence of single and multiple stones, and the occurrence of stones in the gall bladder, coincidently with stones in the duct.

CHARLES G. SUTHERLAND, M.D.

**Gall-bladder Visualization in Jaundiced Patients.** Hillyer Rudisill. *Jour. Am. Med. Assn.*, Nov. 8, 1930, XCV, 1425.

It is quite generally believed that it is not desirable to advise cholecystography in jaundiced patients. Ten jaundiced patients have been among a group coming in a routine manner for cholecystography. In all but one, the examination revealed useful information without ill-effect to the patients. There is no contra-indication to attempted gall-bladder visualization in obstructive or extrahepatic jaundice. In eight of ten jaundiced patients submitted to gall-bladder dye injection, the clinical diagnosis was catarrhal jaundice.

It is advisable to give intravenous tetrathal-ein sodium solution to jaundiced patients as a possible means of helping to differentiate the causes of jaundice.

CHARLES G. SUTHERLAND, M.D.

**Cholecystographic Diagnosis of Papillomas of the Gall Bladder.** B. R. Kirklin. *Am. Jour. Roentgenol. and Rad. Ther.*, January, 1931, XXV, 46.

Although benign tumors of the gall bladder are rated as rare by pathologists, the Mayo Clinic, during the last seventeen years, has found papillomas in 8.5 per cent of more than

17,000 gall bladders removed surgically. The clinical and pathological significance of papillomas has not been fully determined, but in many cases at the Clinic, even though they were small and not accompanied by definite cholecystitis, they seemed to have a causative relation to the patient's symptoms, for cholecystectomy was followed promptly by relief. By the use of painstaking cholecystographic technic, the author is able to differentiate, roentgenologically, between papillomas and stones. On that basis the diagnosis of papillomas has been ventured in 20 cases, in four of which the diagnosis was confirmed by operation. The especial characteristics, as seen on the roentgen film, in contrast with non-papillomatous lesions, are: unchanging position within cholecystic shadow; small evenly rounded defects, usually marginal and never at the fundic pole; in most instances only one or two visible defects, but when multiple never closely aggregated; often seen only at the twentieth hour (two hours after a fatty meal).

The author concludes that, although only a few cases are presented, the results thus far obtained may have a broad bearing in the future on the diagnosis of tumors of the gall bladder.

J. E. HABBE, M.D.

**Cholecystography by Means of the Oral Administration of the Dye.** Bruno Thom. *Röntgenpraxis*, Jan. 1, 1931, III, 17.

The results of oral cholecystography in 702 cases are evaluated by the author. Only after Kirklin showed that the addition of unfermented fruit juice makes the absorption better, and after a preparation was offered which contained the fruit acid, oral tetragnost (Merck), could this method compete with the intravenous method. In about 15 per cent of all cases in which the oral administration is used, may one expect nausea, vomiting, or diarrhea. Taking the dye only one hour after eating three egg-yolks seems to decrease the nausea, while giving it on an entirely empty stomach seems to induce vomiting much more frequently.

In 73 cases, both the intravenous and oral administration were used. In 8, there was

a definite filling after taking the dye by mouth, while the intravenous method did not show any filling; in 12, the contrary took place. Since intravenous cholecystography usually gives a denser shadow, one should realize that too dense a shadow may obscure small stones, as has happened in this series. A non-functioning gall bladder may be found occasionally in other diseases, probably caused by secretory disturbances of the liver and gall bladder, when the gall bladder itself is normal.

Orator found a non-functioning gall bladder in 60 per cent of 25 cases of gastric or duodenal ulcer; Grebe found 26 per cent. These percentages, however, cannot be correct, in the author's opinion. In order to have a more definite knowledge on this question, a large number of ulcer cases should have a cholecystographic examination. The dye test may show a non-functioning gall bladder also in patients with an exophthalmic goiter or diabetes. According to most writers, a non-filling gall bladder is found in patients with exophthalmic goiter in about 50 per cent of all cases. The author examined six cases and found a non-functioning gall bladder in all of them. The question, whether or not the gall bladder empties itself by muscular contraction, seems definitely settled in the writer's opinion. He has seen definite waves of contraction in a series of films. A roentgenologic visualization of the choledochus is very rare, if the usual technic is used. The author has been able to show it fairly regularly after giving Cholotonon, a preparation which is supposed to contain the hormones of the liver and the extrahepatic system.

H. W. HEFKE, M.D.

#### GASTRO-INTESTINAL TRACT (DIAGNOSIS)

**Enemata: From the Anatomical and Physiological Standpoints.** Silas A. Lewis. *California and Western Med.*, January, 1931, XXXIV, 31.

The author discusses the anatomy of the colon, emphasizing the character of the bowel, especially the angulation at the hepatic and splenic flexures, and the increased musculature of the descending colon. He also emphasizes the amount of residual fluid found after evacuation of the enema.

The giving of large enemas dilates the cecum and allows the enema to flow into the ileum, carrying with it colonic bacteria. This, the author believes, may be etiologic of ileo-colitis. Large enemas weaken the musculature of the colon and are pocketed behind the splenic and hepatic flexures. The article is illustrated with numerous X-ray cuts.

FRANCIS B. SHELDON, M.D.

**Peptic Ulcer: The Diagnostic Value of the Roentgen Ray before and after Treatment.** Edward S. Emery, Jr., and Robert T. Monroe. *Am. Jour. Roentgenol. and Rad. Ther.*, January, 1931, XXV, 51.

The authors fully recognize the value of the roentgen examination in the diagnosis of peptic ulcer (in 93 per cent of a series of 510 cases in which the diagnosis was definitely established, an ulcer was demonstrated roentgenologically), but upon analysis of a large series of case records from the Peter Bent Brigham Hospital in Boston, they find the same method of examination much less reliable and helpful in following the course of the lesion. Because after long continued study of many ulcer cases, some showed stationary conditions for years, the opinion is ventured that it may be foolish to advise severe and time-consuming surgical or medical treatment, merely because the presence of a gastric or duodenal ulcer can be shown. As regards the X-ray diagnosis of ulcer, the authors believe the errors in diagnosis to be chiefly those of omission, but even these were found to be surprisingly few.

Retention, determined by the six-hour roentgen examination, was found to be present in 50 per cent of gastric and 44 per cent of duodenal ulcers, but in the majority of the cases, it was small (a trace to 20 per cent). Retention determined clinically agreed closely in 67 per cent of the cases, but in the remaining 33 per cent, the clinical and roentgen retention differed as to the degree present. Hence one would not be justified in advising surgery for relief of obstruction before checking the retention reported present by the roentgen study with that noted by the clinical examination. An analysis of 140 duodenal ulcer cases, treated by several forms of med-

ical and surgical measures, revealed the duodenal deformity persistent upon re-examination roentgenologically following treatment in 94.3 per cent. The small percentage of cases showing disappearance of the duodenal deformity were in every instance treated only medically. In five patients with combined gastric and duodenal ulcer, all but one showed disappearance of the gastric deformity under treatment, but the same number showed a similar or increased deformity of the duodenal bulb.

The authors conclude with the statement that, in their opinion, a diagnosis of healed duodenal ulcer is at present impossible by roentgen examination, and add, rather pessimistically, that this lesion is a very chronic one, rarely cured by treatment.

J. E. HABBE, M.D.

**The Differential Diagnosis of Benign Tumors of the Stomach and Intestines.**  
Franz Schmitz. *Röntgenpraxis*, Dec. 15, 1930, II, 1118.

The roentgenologic findings and clinical history of a patient who had two rather large submucous myomas of the stomach are described. Most benign gastric tumors are polyps, myomas being distinctly rare. Another case is described in which multiple small filling defects were found in the esophagus. On account of their multiplicity and well defined outlines, a benign polyposis was diagnosed. The patient died, with increasing obstruction and cachexia. Inflammatory tumors may simulate a malignancy in the colon, especially when associated with diverticulitis. Even a careful examination of the "mucosa relief" does not always assist in arriving at a positive diagnosis, and, therefore, repeated examinations must be made.

H. W. HEFKE, M.D.

**Roentgen Diagnosis of Gastric Syphilis.**  
Leon T. LeWald. *Jour. Am. Med. Assn.*, Jan. 17, 1931, XCVI, 179.

The author made his first roentgenologic diagnosis of gastric syphilis in 1913. The diagnosis was made prior to the examination of the blood, which was later reported as giv-

ing a four plus Wassermann reaction. The diagnosis was confirmed by operation. The case was evidently one of congenital syphilis and has been re-examined several times, the last time in June, 1930. A second case of congenital syphilis was seen later in 1913. In September, 1916, 11 additional cases were reported by the author and about 40 additional cases have come under his observation, in which the diagnosis of gastric syphilis has been made or suggested from the roentgenologic appearance. The more interesting of these cases are reviewed. Syphilis of the stomach is relatively more frequent in occurrence than the number of reported cases would appear to indicate, and the importance of a correct diagnosis of this condition is not yet thoroughly appreciated. Congenital cases may escape diagnosis owing to the fact that syphilis may not be suspected, and other syphilitic manifestations may be lacking. Diminished acidity of gastric contents and the absence of free hydrochloric acid are explained in some cases by the rapid emptying of the stomach and in others by the involvement of the acid-producing portion of the stomach.

It is inadvisable to make a diagnosis of carcinoma of the stomach or subject a patient to operation for supposed carcinoma of the stomach, especially when the possibility of an extensive resection is under consideration, without submitting the patient to a roentgen examination by a roentgenologist of sufficient experience to enable him to make a differential diagnosis between gastric carcinoma, linitis plastica, ulcer, or syphilis of the stomach. In doubtful cases a diagnosis may be established by determining improvement in the appearance of the stomach on roentgen examination after antisiphilitic treatment has been actively undertaken, especially after using arsphenamine, mercury, and iodides. In some cases surgical intervention may be necessary because of extreme cicatrization, especially involving the pyloric end of the stomach, producing an obstructive lesion. Extensive resection of the stomach should be carefully avoided when the diagnosis of gastric syphilis has been made roentgenologically, or when suspected by the surgeon because of peculiar types of gastric

lesions which differ from those usually encountered in ulcer or carcinoma of the stomach. Syphilitic deformity of the stomach has been proved roentgenologically to disappear after prolonged antisyphilitic treatment, and no recurrence of symptoms has occurred in a series of cases studied over a period of from ten to seventeen years.

CHARLES G. SUTHERLAND, M.D.

**Syphilis of the Stomach.** Luther L. Hill, Jr. *Southern Med. Jour.*, December, 1930, XXIII, 1153.

At present there is a marked variation in the criteria for a diagnosis of gastric syphilis, and, doubtless, many cases reported have been confused with other conditions. Even among pathologists there is considerable difference of opinion as to the anatomical evidence which warrants such a diagnosis. The criteria set forth by Harris and Youmans as being "reasonably conclusive" are: "(1) evidence of organic disease of the stomach, which, on X-ray examination, is indistinguishable from carcinoma; (2) a comparatively young individual; (3) the presence of other evidence of syphilis; (4) a qualified improvement under antisyphilitic treatment; (5) in operative cases, demonstration of tissue changes compatible with syphilis." The demonstration of the lesion in the stomach by the X-ray is essential, because systemic syphilis may give symptoms of stomach disorders, without organic involvement of the stomach.

W. W. WATKINS, M.D.

**Gastric Syphilis: Observations Based on Ninety-three Cases.** George B. Eusterman. *Jour. Am. Med. Assn.*, Jan. 17, 1931, XCVI, 173.

The traditional conception of late or tertiary lesions of acquired syphilis of the alimentary tract is confined almost entirely to those of the mouth, nasopharynx, and rectum. In the light of our present knowledge, based on authentic pathologic and clinical investigations, with the possible exception of the esophagus, which seems rarely affected, it is still an unsettled question as to which organ of the gastro-intestinal tract is most frequently in-

involved. Undoubtedly, routinely made serologic and roentgenoscopic examination of patients with digestive disturbances has led to the eventual disclosure of gastric lesions of syphilitic origin and to a better knowledge of their incidence in the living subject. Gastric syphilis is common in China. The incidence in Russia seems to be high. Then, in order of probable frequency, come France, Austria, Germany, and England.

The diagnostic aspects of gastric syphilis may be summarized as follows: The majority of the patients fell into the period from the second to the fourth decade of life, the average age was about 36 years; the gastric disturbances were usually marked and progressive, with an average duration of two years; the symptoms depended, in a large measure, on the site and extent of the lesion and the existing complications; achlorhydria, or subacidity, especially the former, was the rule; palpable mass, retention, nausea, anorexia, anemia, cachexia, gross hemorrhage, and occult bleeding were infrequent, in contrast to their incidence in carcinoma, a disease in which the laboratory data usually simulated those of gastric syphilis.

The roentgenologic manifestations, although not pathognomonic, were those of circumscribed or diffuse involvement of the gastric wall, rather than an intrusion into the lumen by a growth, which produced contraction of variable degree, stiffening, lessened mobility, and absence of peristalsis. The pylorus was usually gaping; less frequently it was obstructed. The diagnosis was often inferential because of the frequent absence of a palpable mass corresponding to the position of a filling defect, and because of the disproportion between the patient's general condition and the extent of the gastric involvement, as revealed by the roentgenoscopic examination. In 70 per cent the lesion was of the prepyloric type, the defect was concentric, rather symmetrical, and of variable extent upwards. In 22 per cent the lesion was of the median or dumb-bell, hour-glass type, and in the remainder (8 per cent) the involvement was diffuse.

Modern scientific methods of diagnosis and

treatment, coupled with the knowledge gained from histopathologic study of resected material in cases in which operation had been performed erroneously for carcinoma, reveal the fact that gastric syphilis is not as rare as is generally supposed. The disease simulates gastric carcinoma more frequently than any other lesion. In all cases of syphilis in which a demonstrable gastric lesion is present, regardless of the roentgenologic type or extent, the condition should be regarded as syphilitic until it is proved otherwise.

CHARLES G. SUTHERLAND, M.D.

### GENITO-URINARY TRACT (DIAGNOSIS)

**Unusual Duplication of Renal Pelvis.** Hermon C. Bumpus, Jr. *Jour. Urology*, January, 1931, XXV, 39.

Until recently, whenever duplication of the kidney pelvis occurred, the division was considered transverse, one pelvis being situated above the other. This view was maintained by Young and others. Potter and Sexton believed the division might be longitudinal as well, with one pelvis anterior and one posterior, and demonstrated a case by which their opinion was confirmed. The author reports another case of longitudinal fission, with one pelvis superimposed on the other. A supernumerary kidney must be considered.

DAVIS H. PARDOLL, M.D.

**A Giant Ureteral Calculus.** Frank S. Patch. *Canadian Med. Assn. Jour.*, October, 1930, XXIII, 553.

This is a case report from the urologic service of the Montreal General Hospital. The clinical history is as follows: male, aged 35; pains in left groin; thick urine; history of a blow in the pit of the stomach four months previously; temperature 104°; urinary frequency and burning; urine contains pus. X-ray examination showed a large oval shadow in the left pelvis, in the anatomical situation of the ureter. Cystoscopic examination showed a regular, rounded bulging on the left side of the bladder. Ureteral catheter was obstructed 2 cm. from the mouth of the left ureter. The ureterogram of this side showed

the fluid leaving the catheter, and a thin film spreading around the lower half of the shadow. The diagnosis was left ureteral calculus. At operation the left ureter was exposed extra-peritoneally—greatly dilated, the walls thickened, with a kink just above the brim of the pelvis. A large stone was felt low down in the ureter. An incision was made in the ureter above the calculus, the stone removed by forceps, with great difficulty, and a drainage tube left in the upper ureter, but a probe could not be passed into the bladder. Subsequently there was very little urine drainage through the tube, and no indigo-carmin, injected intravenously, appeared during a five-hour observation.

After two weeks cystoscopy was again performed, and the ureter was found still obstructed in its lower portion. A pyelogram, secured by injection through the drainage tube, showed a greatly distended ureter and kidney pelvis. One week later left nephrectomy and ureterotomy were performed, the ureter being removed down to the bladder. The kidney was found markedly atrophied, and the pelvis and ureter greatly dilated. The report is well illustrated by X-ray reproductions.

L. J. CARTER, M.D.

**Clinical Application of Bladder Tumor Pathology.** Paul W. Aschner. *Am. Jour. Surg.*, October, 1930, X, 67.

The author arrives at the following conclusions, after a very comprehensive study of 285 cases of bladder tumor pathology. In 97.5 per cent of the cases, reliable information regarding the character of bladder tumors is obtained by cystoscopic biopsy. It is chiefly in multiple tumors and papillomatosis that unavoidable failures occur. Biopsy alone does not determine prognosis in cases of malignancy.

In cases in which cystoscopic examination reveals papilloma and there is response to fulguration, a biopsy diagnosis of malignancy is a signal for more radical therapy (radium or surgery). General tumor terminology and clinical requirements may be applied to bladder tumors in a harmonious manner. They may be either benign or malignant. Cell-grading, as a basis for classification, is not as prac-

tical for clinical purposes, and the prognosis, based on this, does not coincide with the late results in this series. A more reliable guide to the gravity of the situation is the presence or absence of infiltration. Resectability depends upon the site of the malignant tumor and influences prognosis materially. Segmental resection of the whole thickness of the bladder wall is the procedure of choice in cases which are considered surgical, following a biopsy diagnosis of carcinoma. Recurrence often results if this procedure is not performed in pedunculated tumors, as gross inspection cannot reveal stalk invasion and tumor cells in the blood vessels at the base.

That papillary carcinoma develops from papilloma in a considerable percentage of the cases is doubtful from clinical observation, yet histological studies tempt one to believe so. Only 30 out of 138 papillary carcinomas failed to show evidence of infiltration. There is a probability that this may represent an earlier stage in the development of the disease. Since other lesions may stimulate neoplasms very closely, it is essential to obtain a biopsy specimen before undertaking radical surgery.

DAVIS H. PARDOLL, M.D.

**Intravenous Urography (Swick Method).**  
Leopold Jaches. *Jour. Am. Med. Assn.*,  
Nov. 8, 1930, XCV, 1409.

Continuing the essay of Swick, the author discusses the roentgenologic features. The present substance, under normal conditions, is excreted as such through the urinary tract within from eight to twelve hours to the extent of from 85 to 95 per cent. Iodism has never been observed. Its tolerance is exceedingly great. From 45 to 65 per cent of the substance is normally excreted during the first two hours. For this reason the roentgenograms show their greatest intensity during this period. The roentgenologic technic is discussed in detail. A comparison of the intravenous method with the cystoscopic or retrograde method favors the intravenous method, with an added advantage that it demonstrates not only the anatomy of the urinary tract, but also its function.

CHARLES G. SUTHERLAND, M.D.

**Experimental Research Concerning Intravenous Pyelography in Pathological Conditions of the Kidneys.** Gerhard Gabriel. *Acta Radiologica*, 1930, XI, Fasc. 5, No. 63, p. 500.

By radiation of the kidney and by ligation of the ureter, renal artery, and renal vein, the author has attempted to study in experimental animals the pathological conditions which disturb the normal appearance of the urinary tract in intravenous pyelography.

He concludes as follows from these studies:

1. Damage of the kidney by radiation delays the excretion of the dye.
2. Tumors of the kidney which have destroyed a considerable portion of the parenchyma also delay excretion.
3. In chronic blocking of the kidneys excretion is so slow that good visualization of the urinary tract is impossible.
4. Interference with the arterial blood supply of the kidney delays the excretion of the dye.
5. Purulent infections of the renal pelvis and kidney proper affect greatly the excretion of the dye.
6. In paranephritic abscess visualization occurs as long as the renal parenchyma is not involved.
7. Any condition, whether in the ureter or outside it, which delays the passage of the urine from the kidney to the bladder, leads to stasis in the renal pelvis and delayed filling.
8. The normal rapid excretion of the dye is delayed by temporary compression of the ureter. Such a condition sometimes is seen in pregnant animals. Artificial compression from outside the body may be used by the roentgenologist for this purpose; this procedure often results in excellent visualization of the kidney pelvis.

ALAN L. HART, M.D.

**A New Urographic Medium: Emulsified Campidol (an Iodized Rapeseed Oil).**  
Adolph A. Kutzmann. *Am. Jour. Surg.*,  
November, 1930, X, 320.

Campidol is an iodized oil containing approximately 44 per cent elemental iodine. To adapt it to urographic use, a stable emulsion



was made using campidol, acacia, and distilled water. This results in a mixture containing from 10 to 11 per cent elemental iodine, making it equal to sodium iodide for roentgenographic use. Emulsified campidol, as a urographic medium, is miscible with water. It is inert, non-toxic, non-irritating, and casts excellent roentgenographic shadows, as to detail and intensity, in all parts of the urinary tract. The author has used it in over two hundred and fifty cases and believes it to be superior to sodium iodide for this purpose.

HOWARD P. DOUB, M.D.

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**Excretion Pyelography with Abrodil.** H. Bronner and J. Schueller. *Surg., Gynec. and Obst.*, February, 1931, LII, 254.

The sodium salt of iodo-methane-sulphonic acid, a white crystalline powder, is called "abrodil." This substance, when injected intravenously (20 grams dissolved in 70 to 100 of distilled water), produces a solution which can be sterilized, and its iodine is tightly bound and is not split off within the body. It can be used in the above percentage in pregnant women and tuberculous patients, and appears to be contra-indicated only in those patients suffering from the severest form of kidney insufficiency. This method can be used in ambulatory patients, and also has been used in 15 to 20 per cent solutions for retrograde pyelography. X-ray films are best taken during the first hour after the injection.

DONALD S. CHILDS, M.D.

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**Interpretation of Double Ureters.** Leonard P. Wershub. *Am. Jour. Surg.*, October, 1930, X, 122.

The author reports several interesting anomalies of the ureter. Modern diagnostic methods in urology have been responsible for the increase in the number reported. The embryologic defects are represented by their anomalies. Surgical complications are more prone to develop in these conditions because of the possibility of interference with urinary function, yet this does not imply that all

anomalies are pathologic. Only in cases in which there is obstruction and subsequent infection does renal impairment follow. Duplication may not be complete, the fusion occurring either high up or low down. An abnormally located pelvis, in relation to the kidney itself on pyelography, should lead one to suspect an anomaly.

In duplication of ureteric orifices one should be careful in differentiating the urine recovered by catheterization, as one lobe may furnish a clear specimen, while the other may be cloudy. Clear urine obtained subsequent to a previous specimen of cloudy urine does not necessarily imply a spontaneous recovery from kidney infection.

DAVIS H. PARDOLL, M.D.

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**The Demonstration of the Kidneys with Abrodil, and Some Remarks about the Roentgen Stereoscopy of the Kidney.** W. Teschendorf. *Röntgenpraxis*, Oct. 15, 1930, II, 937.

The author, although not optimistic about the demonstration of the urinary tract by intravenous injection of dyes when he began to use them, comes to the following conclusions: (1) The demonstration of the urinary tract, by means of the intravenous injection of dyes, has the advantage that it is a functional test at the same time (specific gravity test); (2) it makes an examination possible in cases in which introduction of ureteral catheters is not possible; (3) the danger of infection is avoided; (4) it allows the simultaneous demonstration of both kidneys, often not possible by means of the ureteral catheter; (5) it is much less severe for the patient than a cystoscopy.

Uroselectan and abrodil (a new German preparation) have been used. Abrodil is entirely non-toxic, as is uroselectan. Only 20 gm. of the substance are necessary, diluted in 50 c.c. of distilled water. An increase in the amount of abrodil does not increase the density of the shadow, even 10 gm. being sufficient in some cases. Dryness in the mouth and a flushed face are observed after the injection, but are absent when the 20 gm. are

diluted in 100 c.c. of distilled water. A compression bag over the ureters in the sacro-iliac region seems to improve the results. A good filling of the kidney pelvis, however, even with the best technic, is not always possible. Stereoscopic examination of the urinary tract, demonstrated by uroselectan and abrodil, has been a great help, the rather soft shadows of the pelvic and ureteral filling being more marked in the stereogram by the addition. The introduction of a ureteral catheter, with stereoscopic films, seems better than abrodil or uroselectan and stereograms. The introduction of abrodil in a 40 per cent solution into the duodenum did not give a contrast shadow of the pelvis and ureters, probably because the solution was too concentrated. Films of the arm and shoulder, taken during the intravenous injection, show all the veins of the arm up to the subclavian vein. Abrodil might well be used for the demonstration of blood vessels.

H. W. HERKE, M.D.

**Roentgen-ray Diagnosis of Urologic Conditions.** H. King Wade and H. Clay Chenaault. *Jour. Arkansas Med. Soc.*, October, 1930, XXVII, 97.

These authors summarize a short general paper on the use of the X-ray in urology, as follows: (1) Urology and roentgenology are inseparable from a urologic diagnostic standpoint; (2) modern urologic X-ray equipment is essential in the diagnosis of urologic conditions; (3) the urologist may assist in the diagnosis of obscure surgical and gynecological conditions by means of the roentgen ray; (4) the X-ray is invaluable in the pre-surgical location of calculi in the genito-urinary tract.

W. W. WATKINS, M.D.

**Bone Suppuration and Renal Calculi in Children.** Milton C. Borman. *Am. Jour. Dis. Child.*, October, 1930, XL, 804.

A case of a boy, aged 9, with bilateral renal and ureteral calculi, and an overwhelming osteomyelitis of the tibia, is reported. Hematuria was the only clinical evidence of uro-

lithiasis. The calculi remained unsuspected and undiscovered until necropsy, at which time they were found to be composed of practically pure calcium phosphate with a small amount of organic matter. Less than 50 per cent of urinary calculi are so composed, according to Thomson, and in a series of 203 cases, reported by Thomas and Tanner, only one showed calculi in both kidneys and ureters.

The author reviews references in the literature concerning the incidence of renal calculi in infancy and childhood, and their frequency in patients with fractured spine and with bone suppuration. He states that the calculus formation in his case was probably definitely dependent on the osteomyelitis and was not simply an associated incidental condition. It is important, therefore, to suspect urolithiasis in cases of bone suppuration in children and adults.

F. B. MANDEVILLE, M.D.

**Para-urethritis.** Sidney J. Silbar. *Jour. Urology*, January, 1931, XXV, 85.

The author finds that para-urethral ducts are a cause in the chronicity of gonorrhea. They may act as foci of infection and cause a recurrence of an infection. The infection may linger within their portals over a long period of time. Their occurrence, while uncommon, is greater in cases of normal meatus than in hypospadias.

An indispensable aid in recognizing and locating the para-urethral ducts and their ramifications is the use of the roentgenogram. An opaque solution injected into the orifice of the ducts or the urethra, when it communicates, may be employed, and both antero-posterior and lateral views taken, the same principle being employed as with a sinus or fistulous tract. The treatment consists of cauterization of the duct and its complete obliteration whenever possible.

DAVIS H. PARDOLL, M.D.

**Intravenous Urography by Means of the Sodium Salt of 5-Iodo-2-Pyridon-N-Acetic Acid.** Moses Swick. *Jour. Am. Med. Assn.*, Nov. 8, 1930, XCV, 1403.

A comprehensive review of the experi-

mental work preceding this preparation is interesting. This work was begun with N-methyl-5-iodo-2-pyridon, synthesized by Professors Binz and R  th. The study of its excretion through the kidney and into the bile, and its iodine content (54 per cent) led to the thought that the substance might be applicable for roentgenologic purposes. Simultaneous studies of its excretion, limited to determination of the iodine component, revealed about 75 or 80 per cent of the injected iodine in the urine in from twelve to sixteen hours.

The experience with this substance brought out the need for a modification, possessing better tolerance and greater solubility, so that a larger dose could be administered. When a preparation having a lower iodine content, and the sodium acetate group substituted for the methyl, was furnished by Professor Binz, the clinically applicable and successful substance, 5-iodo-2-pyridon-N-acetate of sodium, was finally obtained. The sodium salt (42.2 per cent iodine) is non-toxic, very soluble in water, and neutral in its reaction. The tolerance for this compound is exceedingly great. The blood urea, phenolsulphonephthalein, the indigo carmine, and the dilution and concentration tests are of great assistance in establishing the contra-indication to the application of this method in a given case of bilateral advanced kidney disease. Where the blood urea is high, and the concentrating power of the kidney poor, the method yields few anatomic data and becomes not only superfluous but perhaps is attended with danger. The administration and dosage are given in detail. The reactions, contra-indications, and application of the method are interestingly discussed.

CHARLES G. SUTHERLAND, M.D.

**Roentgenologic Diagnosis in Tuberculosis of the Kidney.** B. H. Nichols. *Texas St. Jour. Med.*, August, 1930, XXVI, 283.

This paper omits the clinical, urinary, and cystoscopic findings in kidney tuberculosis. It discusses the types of tuberculosis, their pathology, and the use of pyelography. The author summarizes as follows:

1. In every suspected case of renal tuber-

culosis, stereoscopic films should be made, showing the size, shape, and position of both kidneys.

2. Irregular calcifications of varying density are characteristic of renal tuberculosis in the process of repair, as are also calcific deposits in the walls of the ureters.

3. A pyelogram can be made of the suspected kidney without hesitation, even though tubercle bacilli are found in the urine.

4. When a diagnosis is made of tuberculosis in one kidney, it is necessary, in order to decide upon the advisability of operation, to determine the condition of the other kidney.

5. A pyelogram of the unaffected kidney can be made by the intravenous route, without risk of infection, and both kidneys may thus be shown at the same examination.

6. The presence of a localized destructive lesion near or at the base of a papilla, with the pelvis and other calices normal, is an indication of early renal tuberculosis, particularly if the affected area has irregular, serrated edges.

7. Multiple strictures of the ureter, in combination with pyonephrosis which has apparently involved only portions of the kidney, are highly suggestive of tuberculosis.

8. In advanced cases there may be marked pyonephrosis with areas not unlike an ostrich plume. These are characteristic.

9. The pyonephrosis may be complicated by hydronephrosis, particularly in cases in which there is stricture of the ureter.

10. A perinephritic abscess, with a fistula into the intestine, is apparently always tuberculous.

11. The final diagnosis of renal tuberculosis must always be confirmed by the finding of tubercle bacilli in the urine, or by a characteristic history and confirmatory cystoscopic findings.

12. The appearance in the roentgenogram of a more or less characteristic pathologic picture, together with the presence of tubercle bacilli in the urine from the catheterized kidney, will almost always confirm the diagnosis of renal tuberculosis.

13. The best results are secured when the roentgenologic examination is evaluated by a

competent roentgenologist, and the history, physical examination, and cystoscopic findings are interpreted by a capable urologist.

W. W. WATKINS, M.D.

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**Uroselectan: Reactions Accompanying its Practical Application: Report of Cases.** George W. Hartman. California and Western Med., December, 1930, XXXIII, 867.

The author reports a number of cases in which he has used uroselectan intravenously as an opaque medium for outlining the urinary tract. All his patients complained of pain at the site of the injection (in mid-arm or shoulder): however, one patient, in which the gravity method was used, did not complain of as much pain.

Among his conclusions, the author finds that this method is valuable in patients in whom there is an obstruction at any point that would prevent the passage of an instrument, and would also include stricture, double ureter, prostatic hypertrophy, bladder diseases, hemorrhage, ruptured kidneys, infection, fistula; and in children. In two cases reported there was a marked anaphylactic reaction. He suggests that caution be used in thyrotoxicosis, pregnancy, active tuberculosis, acute or chronic renal disease, and circulatory disturbances. Uroselectan will not find a dead kidney. There is no danger of over- or underdistention.

FRANCIS B. SHIELDON, M.D.

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**Anomalous Renal Rotation and Associated Anomalies.** William F. Braasch. Jour. Urology, January, 1931, XXV, 9.

The author presents a very interesting and comprehensive paper on this subject. Fusion, ectopia, rotation alone, and torsion of the kidney; also, embryonic pelves are considered. Anomalous rotation is apparently an important etiologic factor in the pathologic complications which frequently occur with renal anomaly. This condition is most frequently observed with renal fusion and congenital dystopia, although it may occur without any other evidence of renal anomaly. It may be

the cause of urinary stasis and pyelectasis, with resulting renal pain, and may be regarded as a distinct clinical lesion. When rotation of the kidney occurs, secondary to acquired factors, the term "renal torsion" is employed to distinguish it from anomalous rotation. The absence of other evidence of embryonic deformity aids in the recognition of this condition clinically. The so-called embryonic or congenital pelvis is characterized by a sacculated, elongated pelvis, with multiple abbreviated calices extending laterally, and an elongated, cephalic calix. Pain in the kidney of obscure etiology frequently is observed with anomalous rotation, although surgical exploration may disclose little evidence of gross pathologic change other than anomaly.

The treatment consists in the removal of all obstruction to urinary flow. Aberrant vessels or surrounding tissues producing tension on the pedicle or ureter, either permanently or temporarily, are removed. Occasionally resort must be had to nephropexy, plastic repair, or nephrectomy. Hydronephrosis or calculi are the most frequent complications and, if present, require the necessary procedure.

DAVIS H. PARDOLL, M.D.

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**Intravenous Urography with Uroselectan.** John Duff. U. S. Naval Med. Bull., October, 1930, XXVIII, 715.

The introduction of uroselectan for intravenous urography is the most important accomplishment of this decade in urology. Uroselectan contains 42 per cent of organically combined iodine, and the formula is that of a sodium salt — 2-oxy-5-iodopyridin-N-acetic acid. It is freely soluble in water and when injected intravenously is excreted by a functioning kidney in sufficient concentration to give contrast on an X-ray film. The method is particularly valuable when there is partial or complete obstruction of the ureter due to stone, stricture, or tumor, because under these conditions the shadow is quite dense on account of the mechanical retention and concentration of the substance.

At the James Buchanan Brady Foundation of Urology of the New York Hospital no se-

rious reactions have been observed. At the New York Hospital the first film is made in five minutes, the second in fifteen minutes, the third in half an hour, the fourth in one hour, the fifth in two hours, and the sixth in three hours. Von Lichtenberg recommends that the first film be taken in fifteen minutes, the second in forty-five minutes, and the third in one one-half hours. On an average the best film is obtained thirty minutes after injection.

W. W. WATKINS, M.D.

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**Diagnosis and Treatment of Tuberculosis of the Genital Tract.** J. Dellinger Barney, J. Laxton Watson, and Simeon Elliott. *Am. Jour. Surg.*, October, 1930, X, 84.

It is conceded by all that genital tuberculosis is but another local manifestation of a primary focus elsewhere in the body, this focus being generally in the lungs or bronchial glands. Whether or not urinary or genital lesions precede one another cannot be ascertained; however, they are not infrequently associated with one another. Hence, it is inadvisable to remove the entire seminal tract in cases of genital tuberculosis, if renal complications are suspected or likely to be present.

It is a fact that in juvenile patients the prostate and epididymis are less frequently attacked by tuberculosis than in the adult, due, no doubt, to the lack both of function and physical development at this time of life. There is some doubt in the authors' minds, based upon both autopsy material and hospital patients, regarding the priority of the prostate in genital tuberculosis. The diagnosis of tuberculosis of the epididymis usually yields the characteristic diagnostic features of induration, enlargement, nodularity involving especially the lower pole, and, but insignificant, pain or tenderness. The vas may be thickened and beaded. Most important is the presence of a healed or active sinus. Hydrocele may mask the scrotal pathology, and rarely tubercle bacilli may be demonstrated in the aspirated fluid. Other conditions must be differentiated. Rectal examination will usually reveal the accompanying changes in the

vesicles and prostatic lobe on the side affected, but these may be absent.

The treatment depends almost entirely on what the surgeon believes to be the primary focus of the disease. If the prostate and seminal vesicles are thought to be the point of origin, radical and extensive surgery, with the entire removal of the genital tract, will be advocated. The opinion regarding such a radical procedure, however, varies, some advocating no surgery at all. The authors have had gratifying success with conservative surgery. A modified technic is employed in performing an epididymectomy on the side affected, with ligation and partial excision of the vas on the opposite side, even though it were free from disease at the time of operation; thereby the usual involvement at a later date by tuberculosis of the side not operated upon is prevented, although if present but unrecognized at the time, it will also require removal. This procedure has been followed by comfort and the retrogression of pathological processes in the prostate and seminal vesicles to the point of clinical cure. In addition, hygienic and supportive measures, commonly employed in the treatment of phthisical conditions, are to be rigidly adhered to, together with heliotherapy and tuberculin post-operatively.

DAVIS H. PARDOLL, M.D.

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**Uroselectan Urography.** Milton Weinberg. *Southern Med. and Surg.*, December, 1930, XCII, 874.

Uroselectan for intravenous urography is in its infancy, but there is enough evidence to show that it will be a valuable aid in urological work. The technic is described. Sufficient information may be secured in the first roentgenogram taken ten minutes after the injection to obviate the necessity for further films. On the other hand, in poorly functioning kidneys, twenty-four hours may elapse before a shadow appears. The chief advantages are: (1) Ease of administration; (2) avoidance of discomforts of the cystoscope; (3) a more natural appearance of structures, if good roentgenograms are obtained; (4) use in patients who cannot tolerate cystoscopy; (5) use in pa-

tients who, because of some anatomical abnormality, cannot be examined by the cystoscope; (6) use in cases in which ureteral orifices cannot be found; (7) use in cases in which inflammation contra-indicates cystoscopy; (8) use in children. Obviously the method fails to outline the urinary tract below an obstructing lesion, and, in this and many other cases, it must be supplemented by cystoscopy.

W. W. WATKINS, M.D.

### GENITO-URINARY TRACT (THERAPY)

Present Status of Electrosurgery and Diathermy in the Treatment of Diseases of the Genito-urinary Tract. Abraham G. Fleischman. *Am. Jour. Surg.*, October, 1930, X, 116.

The author cites his experience with diathermy in various genito-urinary conditions over a period of seven years. The technic employed is given, together with illustrations. In order to obtain successful results with this form of therapeutic aid, one must be accurate in the diagnosis of the condition to be treated, possess the proper high frequency machine, with suitable electrodes, and have an exact understanding of the basic principles of high frequency currents.

DAVIS H. PARDOLL, M.D.

Consideration of the Surgical Procedures in the Treatment of Malignant Disease of the Urinary Bladder. Verne C. Hunt. *Am. Jour. Surg.*, October, 1930, X, 69.

The author confines himself to the consideration of the more or less extensive lesions of the bladder which fail to respond to transurethral treatment and demand surgical procedures. In the truly inoperable lesions the greatest prospects of cure and of palliation may be expected from the combined use of surgery and physical agents. Of 480 graded epitheliomas of the bladder, 58 per cent were malignant, graded 3 or 4 (Broders' index). Lesions of the base of the bladder are more malignant than those of the dome or lateral wall. Experience shows that some of the physical agents are more effective in the treat-

ment of the highly malignant cases, because of their greater radiosensitivity. The lesions of lower grade of malignancy are less apt to infiltrate and extend extravasically and, therefore, warrant more extensive surgical procedures, with reasonable assurance of a cure. The author is emphatic in his preference for surgery in operable malignancy of the bladder, and the results thereof are most successful. However, surgery is seldom justified when the percentage of risk is relatively higher than that of the prospect of cure.

Tumors of the lateral and posterior walls and dome of the bladder are best excised by cautery. When infiltration is present, resection may be done, including immobilization of the bladder where necessary. Tumors of the base require consideration of the ureters. Occasionally the ureters are not encroached upon and resection is possible without either resection and ligation or resection and re-implantation into the bladder. The mortality rate was found to be lower in the former.

In cases in which cystectomy is indicated, the ureters should be transplanted into the sigmoid (C. H. Mayo and Coffey methods), one at a time, preliminary to cystectomy, thereby establishing good renal function and satisfactory urinary control, with the ureters in the sigmoid. Cystectomy may then be performed several weeks later, entirely confined as an extra-peritoneal operation.

DAVIS H. PARDOLL, M.D.

### GRENZ RAYS

The Effect of Grenz Rays upon the Skin: Histological Investigations. Karl Herxheimer and Erich Uhlmann. *Arch. f. Dermat. u. Syphilis*, May, 1929, CLVII, 467.

Biological and clinical investigations have shown that Bucky's Grenz rays produce specific effects, as compared with other types of radiation, especially roentgen rays. The authors made a histological examination of radiated skin and found that the Grenz rays penetrate into the skin to a very limited degree. For small doses, which correspond to about one-half of an erythema dose, the influence of radiation upon the epithelium consists in an extensive loosening up of the tis-

sue, in a vacuolization of the cell nuclei, casually in a complete absence of the net structure of the protoplasm, a complete acanthosis and often in a hyperkeratosis and a parakeratosis. Changes in the cutis, however, could not be observed. These effects, which were observed from a histological examination, closely resemble those produced on the skin by ultra-violet radiations. If, however, Grenz-ray doses, which are larger than the erythema dose, are applied, the effects, observed macroscopically, are identical with those produced by overdosage with roentgen rays. Microscopic examination revealed changes in the stratum granulosum and stratum spinosum, together with definite alterations in the basal cell layer and the corium, these alterations being especially manifested in the damage to the endothelium and the adventitious cells of the vessels. The distinction between Bucky's Grenz rays and other types of radiation is therefore justified.

O. GLASSER, Ph.D.

The Absorption of Grenz Rays in Air. Heinz-Theodor Meyer. *Strahlentherapie*, 1930, XXXVIII, 778.

The absorption of Grenz rays in air and the resulting changes in penetration of the remaining beam were studied by the author for potentials from 6 to 12 K.V., by means of an integrating dosimeter. The ionization chamber was independent of the wave length in the region examined. Aluminum filters of from 0.01 mm. to 0.055 mm. thickness were used as absorbers. The results are shown in a number of graphs. It appears that the narrowing of the beam, due to an increase in the focal distance, is more pronounced at higher potentials. For low potentials, the change in the penetration due to air absorption is so small that it is negligible for practical purposes. Since the quality of radiation is greatly dependent upon the thickness of the Lindemann window, the relations between tube potential and penetration of the beam should be determined for each tube by measurements of the half value layer in either aluminum or cellograph. The same holds for the dose curves at different focal distances. Due to the in-

creased absorption in the window, with increasing age of the tube, such measurements should be carried out at least every 100 hours of usage.

ERNST A. POHLE, M.D., Ph.D.

## GYNECOLOGY AND OBSTETRICS

Roentgen Examination of the Female Urethra, Specially in Cases of Prolapse and Incontinence. Einar Thomsen. *Acta Radiologica*, 1930, XI, Fasc. 5, No. 63, p. 527.

The author describes the technic used in visualizing the female urethral tract on roentgenograms. Two methods are used: one consists of applying a barium paste to the urethral walls, and the other of injecting lipiodol while an exposure is made. He illustrates and describes the changes in the course of the urethra, with structural weaknesses in the pelvic floor.

M. J. GEYMAN, M.D.

Low Voltage X-ray for a Therapeutic Menopause. J. Craig Potter. *New York St. Jour. Med.*, Aug. 1, 1930, XXX, 915.

This author calls attention to the fact that the artificial menopause was produced in thousands of cases before the advent of high voltage machines, and that Hanks is still using low voltage for this purpose. Her technic is a kilovoltage of 100, 5 ma., 10-inch distance, 25 mm. copper filter, cross-firing through four areas, for an average of nine minutes to each area. Treatment is given each month after menstruation, half the treatment being given one day, and the other half two days later. An average of three treatments was required to produce a menopause.

W. W. WATKINS, M.D.

Menstrual Headaches. Charles L. Martin. *Am. Jour. Roentgenol. and Rad. Ther.*, September, 1930, XXIV, 267.

In reviewing the histories of gynecological cases sent in for radiation therapy, the author has found that severe recurrent headache, associated with menstruation, has appeared many times as one of the major symptoms

bringing the patient to a physician. One combination of symptoms, consisting of menstrual headache characterized by pains in the occipital or frontal regions, nausea and vomiting, relieved during pregnancy, has occurred frequently enough to indicate the possibility of a specific underlying causative factor. He holds that this type probably has an endocrine origin, and may be partially or completely relieved in a certain number of women past the age of forty by the production with irradiation of an artificial menopause, but that the use of castration in younger women seems of doubtful value and may even accentuate the symptoms. The literature on the subject is reviewed and six cases cited.

J. E. HAMM, M.D.

**The Sterilization of Women by Roentgen Rays.** G. Fritsch. *Strahlentherapie*, 1930, XXXVIII, 739.

The author describes the development of the technic for roentgen sterilization in his clinic. At present two tubes are used simultaneously; the anterior and posterior fields are  $17 \times 17$  sq. cm., and the surface dose amounts to 492 r per area (170 K.V., 30 cm. F.S.D., 1.2 mm. Cu + 1.0 mm. Al, H.V.L. in Cu = 1.5 mm.). This corresponds to approximately 417 r in 10 cm. depth. Only in very rare cases, the patients treated with this technic developed a faint erythema.

ERNST A. POHLE, M.D., Ph.D.

**The Roentgen Ray as an Adjunct in Obstetric Diagnosis.** Harvey B. Matthews. *Am. Jour. Obst. and Gynec.*, November, 1930, XX, 612.

The author calls attention to the fact that radiography is insufficiently employed in obstetric and gynecologic diagnosis. He enumerates the conditions in which the X-ray is a valuable adjunct in obstetrical diagnosis, as follows:

*Those relating to the maternal pelvis:* (1) deformities; (2) pelvimetry; (3) bony or calcified pelvic tumors; (4) separation of the pubic symphysis; (5) amount of healing after pubiotomy.

*Those relating to extra-uterine pregnancy:* (1) tubal pregnancy; (2) abdominal pregnancy.

*Those relating to intra-uterine pregnancy:* (1) diagnosis of pregnancy before other characteristic signs and symptoms appear; (2) diagnosis of pregnancy as early as the fourteenth week; (3) multiple pregnancy; (4) presentation and position of fetus; (5) cephalometry; (6) death of fetus; (7) monsters, anencephalus, hydrocephalus, etc.; (8) spina bifida and other skeletal defects; (9) syphilis of fetal bones; (10) hydatidiform mole (by exclusion); (11) intra-uterine fractures; (12) osteogenesis imperfecta; (13) illegitimate pregnancies in which no examination can be made; (14) diagnosis of pregnancy, presentation, and position in very large fat women, 200 to 300 pounds; (15) routine examination should be made before cesarean section to determine if the child is normally formed.

*Those relating to pelvic tumors simulating pregnancy:* (1) fibroid tumors; (2) myomas and pregnancy; (3) ovarian cysts, particularly dermoids.

*Miscellaneous conditions:* (1) spontaneous version; (2) pseudocyesis; (3) mechanism of labor; (4) mode and method of separation of placenta (Warnekros); (5) lithopedion; (6) location of placenta (amniography, method of Menees, Miller, and Holly); (7) proof of extra-uterine life (Vogt).

With regard to dangers to the fetus, the author, an obstetrician, says: "We feel sure that no pregnancy, regardless of its stage of development, is damaged by diagnostic roentgenology properly carried out."

JACOB H. VASTINE, M.D.

**Radium in Gynecology.** Sidney Forsdike. *British Med. Jour.*, Sept. 20, 1930, No. 3637, p. 468.

The author in this article, by demonstrating the startling differences in technic in vogue at present in radium therapy, is trying to stimulate research in this field, in order that our present knowledge, which is still in its infancy, may be multiplied and some uniform therapy arrived at. He sketches a brief outline of the history of radium in medicine:



how the enthusiasm and unsubstantiated claims of thirty years ago were followed by a period of complete disillusionment in five or six years when radium treatment was left to the few who still had faith; how we are now in the second advent, and the enthusiasm displayed suggests that history is repeating itself. At the present time responsible men are making themselves answerable for statements that from 70 to 80 per cent of early cancers are curable by radium; such claims may possibly be prophecy—they are not history. There is a glut of hastily written books on treatment by radium, and a still greater stream of reports of cases treated within the year. As a result of this present-day enthusiasm sired by our profession and nourished by the press, enormous sums of money have been utilized to purchase quantities of radium for clinical work, without one milligram being allocated for biological research. One would suppose that there was nothing unlearned of the effects of radium upon living tissues, and that, given the supply, the disappearance of the cancer was only a matter of application. A certain amount of work has been done upon normal tissues, tissue cultures, and animal tumors. The knowledge gleaned from these sources is of great value, but it must be multiplied a hundredfold before we are in a position to direct the gamma ray with precision and certainty.

The following problems are discussed: (a) whether radium acts directly upon the cell or upon the stroma, and the importance of this question as affecting the dose to be employed; (b) the value of metal screens, and the wide divergence of opinion among such authorities as Cade, Larkin, and Simpson for the absorption of 99.9 per cent beta rays; (c) the problem of split doses—whether the dose should be applied continuously or divided into two or more exposures. Lazarus-Barlow's experiments on the question of a large dose acting for a short time, having the reverse effect from a relatively small dose acting for a longer time on squamous and columnar epithelium, are discussed; (d) the various methods in use in the treatment of regional glands are so divergent that the urgent need of organized research in this direction is ob-

vious; (e) in the production of artificial menopause, there is a difference of opinion not only as to dosage but as to whether it is the endometrium or the ovary that is affected.

With regard to fibroids, the only exception to the rule of excision is in cases in which hemorrhage is the cardinal symptom. In the treatment of cancer of the cervix it is slowly being recognized that the early results are not permanent in the majority of cases, and, therefore, not worth recording except as evidence of the value of radium for palliative treatment.

The author, while remaining a believer in radium, is convinced that to-day surgical treatment offers the patient a better chance of cure.

W. D. MACKENZIE, M.D.

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The Present Value of Irradiation Therapy in Gynecology. Fritz Heimann. *Med. Klinik*, Oct. 17, 1930, XXVI, 1545.

The value of irradiation therapy in gynecologic diseases is considerable; it is one of the most important therapeutic means in this field. Many hundreds of myomas have been treated by irradiation in the author's clinic. The amenorrhea could be induced in almost all cases; only twice, a malignant degeneration was observed and only a few times a renewed growth of the myoma after some years. Surgical removal is practised in questionable cases and in very large tumors. In about 7 per cent of the patients, uterine bleeding was noticed again, but was rarely excessive, most of it appearing as normal menses.

The results of irradiation therapy in myomas are excellent. The severity of climacteric symptoms, caused by irradiation or surgery, seems in either case the same. One must know that the menses may appear once or twice after the roentgen treatment. Excessive menstruation in young women should not be treated by means of irradiation; the danger to the germplasm is too great. Temporary castration is used only in tuberculosis or gonorrhea, as the chances for a later pregnancy are poor.

Roentgen treatment of the spleen in exces-

sive uterine bleeding has impressed the author favorably, and the method is simple. In these benign disorders only roentgen rays are used, as radium has certain technical disadvantages. In amenorrhea and sterility, caused by ovarian dysfunction, a small dose of roentgen rays appears to be of benefit in some cases. No damage is done if one is sure of the amount of irradiation. In climacteric symptoms a small dose of roentgen rays to the hypophysis and thyroid will often achieve good results, when all other therapeutic means have been exhausted. The author's standpoint in the treatment of uterine carcinomas is, that all operable cases should be operated on, that post-operative roentgen treatment is of great value, and that inoperable cases should be treated radiologically.

H. W. HERKE, M.D.

**Newer Methods of Roentgenographic Contrast Diagnosis in Obstetrics and Gynecology.** Julius Jarcho. *Med. Jour. and Rec.*, Oct. 15, 1930, CXXXII, 395.

The author has been using the combination of pneumoperitoneum followed by oil and has designed an apparatus for this purpose. For the pneumoperitoneum, from 800 to 1,500 c.c. of oxygen or carbon dioxide are first injected by the transuterine route if the tubes are patent, otherwise by the abdominal route. The oil is injected through the cervical canal. After 3 c.c. is injected the first roentgenogram is made; then additional films after 5, 8, 10, or even 15 c.c. of oil. Either method may be used alone, or a combination, when one method will not give the desired information. In this way the clinician may map out the pelvic viscera, or outline the inside and outside of the uterus. The same procedure often shows the tubes and normal ovaries, while neoplasms of the uterus and adnexa are often plainly shown. The diagnosis is thus more precise, and often enables one to make an intelligent choice of method of treatment, whether surgery or radiation. Oftentimes when an operation would sacrifice the uterus and make child-bearing impossible, patients will choose irradiation. The procedure can be

carried out by a gynecologist or by a radiologist, preferably by the two together. By using strict asepsis and gentleness of technic, complications will be avoided, and the co-operation of the patient secured.

W. W. WATKINS, M.D.

**On the Therapy of Fibroids and Hemorrhagic Metropathy in the Women's Clinic at the University of Würzburg, 1923-28.** Paul Uebel. *Strahlentherapie*, 1930, XXXVIII, 438.

This statistical paper does not lend itself well to abstracting. In view of the enormous material there, it is recommended for study in the original. Only a few of the principal points can be mentioned here. Sterilization by roentgen rays was carried out by applying one anterior and one posterior field. The dose effective in the ovaries amounted to 275 r. In many cases, it was not necessary to give as high a dose. Sometimes permanent amenorrhea was obtained following the application of about 180 r in the ovaries. Temporary amenorrhea required about 160 r. The equivalent radium doses were 3,000 mg.-hrs. for permanent amenorrhea, and about 1,500 mg.-hrs. for temporary amenorrhea. In cases in which there was suspicion of a sarcoma, from 4,000 to 5,000 mg.-hrs. were given intra-uterine. This dose has been increased lately to 7,000 mg.-hrs. or 830 r with roentgen rays. If roentgen and radium rays are combined, about one-half of the full dose of either agent was used.

Only a few cases were operated on. The indications for operation were indefinite diagnosis, young age of the patient, pedunculation of the fibroid or incarceration, excessive size of the fibroid or degeneration. The entire material is subdivided into clinic patients and private patients. A total of 318 private patients were observed during the period from 1923 to 1928. Two hundred and three had a fibroid, and 115 had hemorrhagic metropathy. Of the fibroids, 17 were treated by curettage, 142 by irradiation, and 44 by operation. The respective figures in the group of hemorrhagic metropathy were 11, 104, and none. A total

of 246 cases, namely, 142 of fibroid and 104 of hemorrhagic metropathy, were irradiated. In the fibroid group, 127 had permanent amenorrhea and 15 temporary amenorrhea. The respective figures for the hemorrhagic metropathy cases were 76 and 28. Of a total of 730 clinic cases, 384 had a fibroid and 336 hemorrhagic metropathy. Six hundred and forty-five were irradiated and 85 operated on. In the fibroid group, 330 were irradiated, 45 operated on, and 19 curetted. The respective figures for the hemorrhagic metropathy were 315, none, and 21. Of the 330 irradiated fibroids, 271 had permanent amenorrhea and 59 temporary amenorrhea. The respective figures for the hemorrhagic metropathy group were 261 and 54. The average hospitalization of private and clinic patients was nine days for radiation therapy and nineteen days for uncomplicated operation.

The author states, in conclusion, that radiation therapy of fibroids and hemorrhagic metropathy has not only given good results in their cases but should be used more in preference to operation.

ERNST A. POHLE, M.D., Ph.D.

## HEART AND VASCULAR SYSTEM (DIAGNOSIS)

Far-reaching Effects of Gamma Rays and Short X-rays upon the Human Heart: Electrocardiographic Results of Cancer Treatments Given without Direct Irradiation of the Heart. J. E. Gendreau. *Ann. Surg.*, January, 1931, XCIII, 476.

Cardiovascular disturbances produced by large doses of gamma rays and short X-rays, even when the heart itself has not been directly treated, are accompanied by symptoms of dyspnea, tachycardia, general fall of blood pressure, and asystolia in very serious cases. The author has used electrocardiograms before, during, and after treatments by radium and X-rays. Many records were taken in cancer cases in which the irradiation area was not directly over the heart. In each case the changes are appreciated by comparison with the tracings taken before treatments. The records show the action of the gamma rays and the X-rays upon the heart at a distance; by

additional *P* waves, and impure flutter; by flattening of the *P* waves, and auricular fibrillation; by abnormal *Q R S* complexes, in general with lower voltages and reduction of the tracings to a line, occasionally with maximum voltages—very deep *Q* and *S* deflections; by deep inverted *T* waves, sharp and rounded, with occasional notchings in the ascending branch. *R T* is constant but *T P* is generally increased and the resulting rhythm slower immediately after a treatment. In premature ventricular contractions on the contrary, *T P* is greatly reduced and *P* immediately follows *T*. The extra systole is generally succeeded by the compensatory pause. Tachycardia is less common than bradycardia.

Electrocardiograms may be useful in the direction of a cancer treatment by irradiations.

F. B. MANDEVILLE, M.D.

The Effect of Amyl Nitrite on the Size of the Heart and the Width of the Aortic Shadow as Determined Roentgenologically. William A. Brams and Herman A. Strauss. *Am. Jour. Med. Sci.*, November, 1930, CLXXX, 618.

In 21 patients the size of the cardiac and aortic shadows was studied roentgenologically before and after the administration of amyl nitrite, including 6 normal persons and 15 with arteriosclerosis. The transverse diameter of the heart was reduced in 18 patients, regardless of whether or not arteriosclerosis or hypertension was present. The width of the aortic shadow was increased in 13 patients. This result also seemed to be independent of the condition of the peripheral vessels or degree of blood pressure.

W. W. WATKINS, M.D.

The Size of the Heart in Goiter: A Tele-roentgenographic Study. Lewis M. Hurxthal, O. J. Menard, and M. E. Bogan. *Am. Jour. Med. Sci.*, December, 1930, CLXXX, 772.

The question of cardiac enlargement from hyperthyroidism has long been unsettled, and many statements have been made without adequate statistical data. A study has been made

of 100 patients with hyperthyroidism and a corresponding number of normal controls. Radiographs were made at a seven-foot distance, and studies made on the basis of age, sex, type of goiter, presence of accompanying heart disease, etc. No definite relationship was found between the duration of the disease or loss of weight and size of heart; cardiac enlargement showed a fairly direct relationship to age and coincident cardiovascular disease; the number of enlarged hearts was practically the same in both toxic and non-toxic goiters; if hyperthyroidism causes enlargement or hypertrophy and dilatation, it is slight.

W. W. WATKINS, M.D.

### HODGKIN'S DISEASE (DIAGNOSIS)

An Analysis of the Lymphadenopathy Question, with Special Reference to Hodgkin's Disease and Tuberculosis. Fred W. Stewart and Charles A. Doan. *Ann. Surg.*, January, 1931, XCIII, 141.

The authors quote: "Our knowledge of Hodgkin's disease has been clarified or rendered more obscure—depending on the point of view—since Sternberg demonstrated the close association of the disease with tuberculosis, and from that time on the tubercle bacillus has never been satisfactorily dissociated from the Hodgkin's picture." Studies are cited which have tended more and more to favor the concept that Hodgkin's disease is a special manifestation of tuberculosis. Recent studies disclose that animals showing a high physiological level of monocytes in contrast to lymphocytes are relatively more susceptible to acute, progressive tuberculosis than those having a low M/L index. The epithelioid cell of the tubercle has its origin from the monocyte, and epithelioid cells as identified in the supravital technic have been found as a part of the cellular reaction in Hodgkin's nodes. The newer bacteriologic studies of Petroff in the dissociation of various pure strains of avian, bovine, and human tubercle bacilli are important. The correlated chemical and biologic studies of the whole group of acid-fast bacilli, under the direction of the Research

Committee of the National Tuberculosis Association, are aiding in interpreting the mechanism underlying the varying pathology characteristic of tuberculosis.

The authors discuss especially the chemical partitions thus far studied, and the phosphatid fraction from the lipoids, as isolated by Dr. R. J. Anderson of Yale University. Comparable phosphatid fractions from human, bovine, and avian tubercle bacilli have been isolated. In a study of 350 clinical cases during the past two years, of which the majority were tuberculous, frequent ability to precipitate the tuberculo-phosphatid in high titer, or the precipitation with a phosphatid antiserum of suspected uncombined antigen, has been demonstrated. Twenty-six of thirty-two cases of Hodgkin's disease showed a capacity of the blood serum to precipitate the phosphatid in a dilution of 1-640 (of an original 1 per cent suspension) or higher. This is well within the range of positive reactions observed in known tuberculous cases. An ultimate understanding of both the pathological agent or factor and the mechanism of adjustment or resistance must precede any final approach toward the control of each definite etiological entity in disease.

F. B. MANDEVILLE, M.D.

The Genetic Neoplastic Relationships of Hodgkin's Disease, Aleukemic and Leukemic Lymphoblastoma, and Mycosis Fungoides. Aldred S. Warthin. *Ann. Surg.*, January, 1931, XCIII, 153.

In 100,000 diagnostic tissue examinations made in the Pathological Laboratory of the University of Michigan between the years 1895 and 1927, there were 506 cases, approximately 0.5+ per cent, of all cases diagnosed as Hodgkin's disease, aleukemic and leukemic lymphoblastoma, and mycosis fungoides. During the same period, in 2,000 autopsies, there were 83 cases falling into the same diagnostic categories.

An analysis of the above material forms the foundation upon which the following conclusions are drawn:

1. Hodgkin's disease, sarcomatous Hodgkin's, aleukemic and leukemic lymphoblasto-

ma. aleukemic and leukemic mycosis fungoides are all true neoplasms and are genetically closely related.

2. Transition forms between all of the types exist.

3. They differ chiefly in the degree of differentiation shown by their cell types, and in their point of origin.

4. They all take their origin from perivascular reticulo-endothelium, or the maternal lymphoblasts of the lymphoid tissues of the body.

5. Those arising from the hematopoietic perivascular reticulo-endothelium take on the type of Hodgkin's, sarcomatous Hodgkin's (reticulocyto-endothelioblastoma), or even of myeloid forms of sarcoma. Those arising from the maternal lymphoblasts have the character of the lymphoblastoma, small-celled or large-celled, aleukemic or leukemic. The maternal lymphoblasts are derived from the same perivascular reticulo-endothelium, but represent a higher stage of differentiation than do the Hodgkin's and the reticulocyto-endothelioblastoma forms. The sarcomatous Hodgkin's of the reticulocyto-endothelioblastoma type represents a greater differentiation than the Hodgkin's type, while the lymphoblastoma represents a higher stage of differentiation.

The more undifferentiated forms, Hodgkin's, sarcomatous Hodgkin's, and typical lymphoblastoma, occur chiefly in individuals of younger ages, while the typical aleukemic and leukemic neoplasms are more frequent in older individuals.

7. They all run a similar clinical course, often with fever, characterized by remissions and recurrence of the tumors, with the development of a progressive tumor cachexia, anemia, emaciation, and prostration. No case has ever been cured; when removed surgically, the regenerated glands become similarly involved in the process. While suggesting analogies with chronic infectious processes, they differ from these in that no mild or cured cases occur, there is no evidence of any immune reaction on the part of the organism, and the process shows a steady malignant progression to the fatal termination.

8. Pathologically, the lesions are neoplastic in type rather than granulomatous; they show

true infiltrations and metastases. In their cell types and architecture they follow definite patterns which cannot be explained on the basis of an inflammatory reaction.

9. There is but one method of treatment which will delay but will not halt the inevitable malignant progress of these growths, and that is the judicious and systematic employment of X-ray irradiation.

F. B. MANDEVILLE, M.D.

Bone Changes in Hodgkin's Disease. Kurt Kremser. *Röntgenpraxis*, Nov. 1, 1930, II, 998.

Lymphogranulomatous involvement of the medulla of bones has been described rather frequently. Changes in the compacta and spongiosa are not so frequent. In fifty-one cases this occurrence was found only twice. The changes in the roentgenogram are destructive in character, proliferative changes not having been observed. The vertebrae seem to be attacked more often than other bones, and only in the later stages of the disease does bone involvement seem to take place, which cannot be differentiated from other metastases in the roentgenogram. It was interesting that, contrary to other metastases, roentgen therapy did not seem to have any effect on the lesions.

H. W. HEFKE, M.D.

## JAUNDICE

The Clinical Significance of Jaundice. M. A. Blankenhorn. *Jour. Am. Med. Assn.*, Oct. 11, 1930, XCV, 1066.

Although the physiologist and the pathologist have in recent times thrown great light on the problem of the formation of bile pigment and on certain functions of the liver, little has developed to help the surgeon with his question about stoppage of the ducts. The first and most important significance of jaundice is the possibility of stoppage of the ducts. To make a diagnosis of obstructive jaundice, one of three common procedures is generally followed: (1) If there is a history of colic, one argues from cause to effect, and says that

the stone that causes colic obstructs the duct; (2) tests for liver disease or tests of liver function can be done to exclude obstruction of the duct; (3) the symptom of jaundice can be studied to see whether obstruction of the ducts alone could give such a distribution of bile pigment.

Schiff reported no exception among 327 normal persons and patients that the van den Bergh direct reaction occurs with jaundice and bilirubinuria, and that the indirect reaction occurs with jaundice with no bilirubinuria, regardless of the pathogenesis of the jaundice. The study of the distribution of bile pigment to see whether stoppage of the ducts alone could explain the jaundice requires relatively simple laboratory methods.

The icteric index and the examination of duodenal contents and of the feces are simple and of good repute when properly interpreted. Cholecystograms by the Graham method unfortunately cannot be used when jaundice has fully developed. No other dye tests can apparently be used when jaundice is present.

CHARLES G. SUTHERLAND, M.D.

**Physiologic Disturbances Incident to Obstructive Jaundice: A Review.** A. C. Ivy. *Jour. Am. Med. Assn.*, Oct. 11, 1930, XCV, 1068.

The physiologic disturbances incident to obstructive jaundice are too numerous to list and to discuss even briefly in a short review. Bile retained in the biliary passages not only may pass into the blood and thus influence many organs, but also may disturb the functions of the liver and the gastro-intestinal tract. Even if bile were not toxic in itself, one would expect disturbances due (a) to the effect of excessive biliary pressure in liver function; (b) to reflexes excited by excessive biliary pressure; (c) to the absence of bile in the intestine, and (d) to the effects secondary to these changes.

The toxicity of bile is discussed, also the liver damage, lack of bile in the intestine, and terminal nephritis. The patient suffering from prolonged jaundice presents a picture that results from the failure of a number of physiologic mechanisms. It is not known

which one is primarily concerned. The fundamental nature of the reactions involved in producing the physiologic disturbances is not completely understood at present. The literature indicates that a carbohydrate diet, with milk and cod liver oil and calcium administration, is a worth-while therapeutic procedure in this condition.

The problem is being actively attacked by several groups of investigators, and the future of the understanding of physiologic disturbances in jaundice augurs well.

CHARLES G. SUTHERLAND, M.D.

### MEASUREMENT OF RADIATION

**Concerning a Source of Error in Calibrating a Müller Low Voltage Tube.** Lothar Böhmer. *Strahlentherapie*, 1930, XXXVIII, 353.

Ionization measurements on low voltage X-ray tubes by interposing diaphragms of different diameters (5, 10, 15, and 20 mm.) revealed the fact that the strength of the beam without a diaphragm was 34 per cent higher than with the largest diaphragm. This may lead to errors in dosage if the calibration has been carried out with a diaphragm while the patient is treated without using one.

ERNST A. POHLE, M.D., Ph.D.

**Measurements of the Half Value Layer in Aluminum.** Heinz-Theodor Meyer. *Strahlentherapie*, 1930, XXXVIII, 329.

The absorption curves for roentgen rays produced at potentials between 30 K.V. and 190 K.V. at 10 K.V., steps were measured in aluminum by means of a large and a pressure ionization chamber. A therapy tube connected to a constant potential apparatus was used. From the absorption curves, the normal and reduced half value layer were obtained. The latter is procured by substituting the radiation used at any given point by its equivalent homogeneous radiation. Curves were then plotted, expressing the quotient obtained by dividing the normal and reduced half value layers. They show a striking irregularity between 90 K.V. and 110 K.V., which is in all

probability due to the influence of the K radiation of the tungsten anticathode.

ERNST A. POHLE, M.D., Ph.D.

**Meteorological-medical Radiation Measurements in Defined Regions of the Spectrum.** K. Büttner. *Strahlentherapie*, 1931, XXXIX, 358.

Based on investigations of Dorno, the author constructed an apparatus consisting of photo-electric cells, actinometer, and filter, which permits measurements in various parts of the spectrum of importance to the meteorologist and physiologist. A number of measuring results in the spectrum of the sun are reported.

ERNST A. POHLE, M.D., Ph.D.

## RADIATION SICKNESS

**The Relation between Cholesterol Metabolism and Roentgen Sickness.** Rudolf Hummel. *Strahlentherapie*, 1930, XXXVIII, 308.

The cholesterol content of the serum is usually lower in man following roentgen deep therapy. In a few cases, the cholesterol is increased about three hours after the exposure. No relation between cholesterol drop in the serum and roentgen sickness could be observed, while the cholesterol drop in the total blood and roentgen sickness seemed to run parallel. The prophylaxis and treatment of roentgen sickness with "Colsil tablets" containing cholesterol, as suggested by Burgheim, were successful only in about 25 per cent of all cases.

ERNST A. POHLE, M.D., Ph.D.

**Immunological and Biochemical Researches on the Biological Action of X-radiation and Radium.** Luigi Cappelli. *La Radiologia Medica*, August, 1930, XVII, 905.

The theory that roentgen sickness is due to the formation of foreign proteins in the body which would cause a defensive reaction in the organism has been the object of study on the

part of the author. He has resorted to immunological methods to attain a greater sensitivity than that obtained with chemical investigation.

The serum of three rabbits which had been given slightly different quantities of X-radiation was tested with the serum obtained from another rabbit heavily irradiated (950 r).

The serum of the latter was taken some hours after treatment; that is, when the general effects of radiation are felt most. The ratios in X-ray dosages were approximately the same as the ratios of the quantities of the substances used in immunological tests. According to the author, the mildly irradiated animal would have supplied the antibody, while the other would have furnished the antigen. No flocculation was observed, however, and the author voices the belief that the cause of roentgen sickness must be found elsewhere.

L. MARINELLI.

## RADIUM

**Post-operative Parotiditis: Treatment without and with Radium.** Fred W. Rankin and Bean M. Palmer. *Ann. Surg.*, December, 1930, XCII, 1007.

In the last four years, there have been 78 cases of post-operative parotiditis at the Mayo Clinic. The condition occurs most frequently following operations on the gastro-intestinal tract, more especially the sigmoid and rectum. Of the 58 cases treated without radium, 23 died—a mortality of 39 per cent. Of the 20 cases treated with radium, four died—a mortality of 20 per cent. Three of the four cases died of causes definitely other than parotiditis, so that the corrected total for radium cases reads 5 per cent. In only two of the 20 cases was it necessary to substitute surgical drainage.

By using radium, particularly by immediate application, within from one to two hours following swelling, the incidence of suppuration and absorption is decreased noticeably, with resulting decrease in morbidity and mortality. The maximal dose consisted of four applications, eight hours in duration, at intervals of eight hours, and of four 50-mg. tubes of ra-

dium. Filtration was through 2 mm. of lead, 1 mm. of brass, and 0.5 mm. of silver; the distance was 2.5 cm., and a total of 6,605 mg.-hrs. was given. The minimal dose was two applications, eight hours in duration, at intervals of eight hours, and of two 50-mg. tubes of radium, with filtration as above, and a total dosage of 800 milligram-hours.

F. B. MANDVILLE, M.D.

**Gynecological Notes, with a Special Reference to the Use of Radium.** Kenneth Wilson. *Med. Jour. Australia*, Dec. 13, 1930, II, 786.

This is a summary and descriptive review of the Heyman, Lacassagne, and Donaldson technic in the treatment of carcinoma of the cervix, with descriptions of the current Continental practice in the use of radium in other gynecologic conditions. Although a purely *réchauffé* dish compounded from existing literature and a visit to European clinics, the paper has value in presenting the prevailing radium practice in a general non-critical manner.

J. G. STEPHENS, M.B. (Syd.), D.M.R.E.

**Cosmetic Results of Electrocoagulation and Radium Treatment, Especially of Carcinoma of the Skin.** A. Buschke and Ludwig Loewenstein. *Med. Klinik*, Oct. 24, 1930, XXVI, 1590.

Electrocoagulation is used only in combination with irradiation therapy in the authors' clinic. The first treatment and its correct administration is most important for the prognosis. Electrocoagulation should be preferred to surgery, as the danger of recurrences and implantation of metastases is much smaller. The tumor thus treated is covered with boric acid ointment for from eight to fourteen days, and radium treatment is instituted at that time. Fractional doses are used, and the lesion usually is healed in from three to eight weeks, depending upon its size. Local recurrences after this combination treatment are not frequent—much less, in fact, than after surgical excision. The cosmetic results are very satisfactory. Benign tumors, such as

warts, pigmented moles, angiomas, and rhinophymas, have been treated by electrocoagulation with good results.

H. W. HERKE, M.D.

**Radium Treatment of Early Epithelioma of the Lip.** Howard Hailey. *Southern Med. Jour.*, December, 1930, XXIII, 1121.

The author states as follows: "I do not believe it is practical to outline a treatment for epithelioma of the lip which will be suitable for all cases." He then discusses the several methods advocated for malignant lesions on the lip, and states his belief, based on personal experience, that radium, properly used, will give a higher percentage of permanent cures of early squamous epithelioma of the lip than any other single method of treatment. His technic is to transfix the lip with several five-milligram needles of radium, just distal to the growth, leaving them in place for seven hours. Radium is also placed on the surface of the lesion.

(*Abstractor's note:* This author does not mention the treatment of the gland areas with X-ray, although he uses a half-strength plaque over the submental area, with 0.5 mm. brass filter, 10 to 12 hours. This appears to me to be a totally inadequate radiation for the lymphatic areas in treating cancer of the lip.)

W. W. WATKINS, M.D.

**The Detection, Estimation, and Elimination of Radium in Living Persons Given Radium Chloride Internally (II).** Howard H. Barker and Herman Schlundt. *Am. Jour. Roentgenol. and Rad. Ther.*, October, 1930, XXIV, 418.

Elimination of radium chloride or other radium salt after introduction into the body by oral, intramuscular, or intravenous routes, has received particular investigation since the so-called "radium poisoning" cases gained public attention. Previous investigators computed elimination by collecting feces and urine, and estimating, quantitatively, the amount of radium excreted daily. From 25 to 35 per cent of that taken by mouth and from 55 to 65 per cent of that given intra-



venously is excreted within from four to five days of administration, but thereafter the rate of elimination in each instance is less than 1 per cent daily.

The present investigation was carried out on 10 patients ranging in age from 30 to 75 years, all of whom had taken radium amounting, in one instance, to as much as 1,130 micrograms of radium chloride, for a varied group of ailments, none of which had responded well to the usual therapeutic measures. The penetrating radiation within the body was tested for by a Wulf-Hess quartz fiber electroscope, while two new Lind ionization chambers, with an electroscope head, were used for detection and estimation of radium in the expired air of the patients, all radium values being expressed in terms of micrograms. Four of the 10 individuals were negative so far as radio-active tests were concerned, and the fifth case showed a mere trace. In three of the five remaining cases the patients had received material so recently that the finding of radio-active materials in their bodies caused no surprise. The two cases showing the largest amounts of radio-active material in their systems had had no radium administration for a period of two years, but each of these had had large amounts (one 890 and the other 1,130 micrograms) for intractable venereal disease.

J. E. HABBE, M.D.

**Hairy Tongue Following Adjacent Radiation.** M. T. Van Studdiford. *Southern Med. Jour.*, December, 1930, XXIII, 1125.

Eight patients with carcinoma of the upper digestive tract (tonsil, tongue, mandible) developed hairy, or black tongue, within from two to five weeks following adjacent radium treatment. The whole lingual mucosa was involved in two cases, the condition persisting for eighteen months. Whether this was due to a symptom-complex inducing hyperplasia of the papillae and pigmentation as the result of the organism found by Weidman (*Archives of Dermatology and Syphilology*, November, 1928, XVIII, 647), or to a stimulation by the irritant effect of radium, or to a lowering of the resistance of the mucosa, allowing

invasion by organisms, has not been determined. The diseased area has a black-brown or yellow-brown fur-like appearance, made up of hairs measuring from  $\frac{1}{4}$  to  $\frac{1}{2}$  inch in length.

W. W. WATKINS, M.D.

**The Present Status of Radium Surgery.** H.-G. Zwerg. *Strahlentherapie*, 1930, XXXVIII, 487.

This is a review of the combined surgical and radium treatment of malignant tumors in the paranasal sinuses, larynx, esophagus, bladder, prostate, rectum, and stomach. Although Regaud does not believe in the value of radium surgery in uterine carcinoma, because of the high development of roentgen therapy, the author feels that the former is of benefit in the treatment of involved lymph glands and parametrium.

ERNST A. POHLE, M.D., Ph.D.

**Radium and its Use in Uterine Diseases.** W. E. Gary. *Kentucky Med. Jour.*, September, 1930, XXVIII, 454.

There is no known method of determining which case will and which case will not respond to radium, without trial, any more than which will or will not be benefited by surgery or other means. Radium and X-rays give off the same rays, but radium can be placed where needed and the selected wave be had by proper screening. The uterus can stand more radiation than any other organ in the body, and radium is the accepted treatment in all cancers of the cervix. If competent surgeons and competent radiologists will co-operate, the future will be bright for increase in the number of cures in malignant disease, especially if the general practitioner will help by sending cases early.

W. W. WATKINS, M.D.

**Radium Therapy in Cancer of the Nose, Larynx, and Esophagus.** H. M. Moran. *Med. Jour. Australia*, Dec. 20, 1930, II, 814.

Obstruction is frequently the primary symptom of tumors of the nasopharynx, by which time it is impossible accurately to gauge the

degree of bone or cartilage involvement. Interference with sinus drainage brings infection in its train. With bone invasion, osteomyelitis occurs; with cartilage invasion, necrosis occurs, and the sinister conspiracy of neoplasm, infection, and necrosis compasses the patient's destruction.

*Cancer of the Maxilla.*—In neoplasms of the superior maxilla the surgical act should be exploited to the utmost and the subsequent irradiation should be as complete as if no surgical treatment had been given. Cylindrical-celled carcinomas predominate; squamous-celled carcinomas may arise by invasion from without or by metaplasia of primary cylindrical-celled growths. Myxosarcomas and angiosarcomas are found. Osteogenic sarcoma is rare. Lymphosarcomas may occur and permit of dramatic, if ephemeral, success. Treatment is best commenced with deep X-radiation. Two weeks later operation follows, and this should expose the growth and, if possible, completely remove it, but even incomplete extirpation is valuable. The preliminary X-radiation prevents scattering of cancer cells, which might be caused by an incomplete operation. Partial removal, although not accelerating the growth according to Ledoux, may yet cause dangerous bleeding and delay the third stage of radium treatment. Radium is next applied either in radon seeds or in tubes. The former gives a fading dose, and adequate filtration cannot be obtained without rendering the seeds bulky. Filtration by 2 mm. of platinum and a secondary filter of Al and rubber is essential. Three tubes each of 10 mg. introduced for eight days for small areas (from 30 to 40 mc. destroyed), or otherwise from 10 to 12 tubes each of 3 mg. for four days (from 25 to 30 mc. destroyed), are employed. These three stages should be completed within one month, and the associated lymphatic glands must then be considered. Ledoux strongly advises irradiation of first relay of lymphatic glands. Close surveillance of these areas is imperative.

*Cancer of the Nasopharynx.*—Fibrosarcoma is more radiosensitive the younger the patient, and in adult growths of this kind surgery is indicated. Lymphosarcomata are best treated

by X-radiation, and this type of growth is probably unique in the respect that irradiation of the primary focus has been known to cause the disappearance of distant metastases. The author commends the search for the cause of this phenomenon, which would reveal new horizons in radiotherapy.

*Laryngeal Cancer.*—In extrinsic growths the tumor is generally inaccessible and radio-resistant, and gland involvement is early, so that palliation only, either by radium used at a distance of several centimeters, or by deep X-rays alone, is possible. The uniform and efficient irradiation of the whole area with radon seeds is usually impossible and the radium bomb has not improved the depressing results. Intrinsic cancer is more hopeful. This is essentially a cancer of the vocal cord, becomes subglottic by extension, but is not by nature highly invasive. It is relatively avascular, remains for a long time unilateral, and gland involvement is usually late. Moreover, an early alteration in voice quality acclaims the onset, and causes the patient to present himself at an early stage in the disease. Surgery gives good results in intrinsic cancer, and radium may give superior functional results, with a better voice quality. For effective radium treatment, the growth must be confined to the chord, and neither anterior commissure nor muscle nor cartilage be invaded. Voice quality is, of course, less important than final cure, and the choice between surgery and radium is as yet undecided.

The greater part of the lateral cartilage is resected, but it is essential that the perichondrium on the inner side should be left intact to shield the larynx from secondary inflammation. From 5 to 10 needles of one-half or one mg. of filtration, 0.5 mm. platinum, and length of from one to two centimeters, are placed vertically in the window thus made, and their tips tucked behind the cartilage, without perforation of the larynx. The threads of the needles are steeped in one in a thousand acriflavine solution. The wound is closed without drainage and the needles left in for from four and a half to eight days. Within ten days the tumor is reduced to a mere nodule, and usually disappears within six weeks. This technic, the only needle technic justifiable

in the larynx, is, of course, suitable only for growths of limited extent on account of the greater distance of the posterior needles from the growth. The author is emphatic in warning against the embedding of needles within the larynx. Glottis edema, following treatment, may necessitate low tracheotomy. Necrosis of cartilage, after deep X-radiation, at any rate, is an exaggerated danger unless the cartilage has become ossified, in which case the secondary rays may produce the condition. If the tumor has become subglottic a preliminary and very thorough distance radiation is advisable, after which the hemilaryngectomy is performed, and the same radium dose given as before. The vegetative or ulcerative type of growth arising in the ventricular cavity or band resembles the mucous membrane type of epithelioma, and is radiosensitive and suitable for deep X-ray treatment.

*Cancer of the Esophagus.*—The author doubts whether or not esophageal cancer is ever cured by our present methods. Inaccessibility, late appearance of symptoms, extensive longitudinal lymphatic spread, and early onset of infection account for the poor results. Fusion of enlarged posterior mediastinal glands may deflect the esophagus, as shown radiographically. The futility of introducing tubes of radium within the structure is thus manifest. Gastrostomy, to place the diseased area at rest, and to provide nutrition, should be the first step. Irrigation with a 2 per cent sodium bicarbonate may reduce the infection. The lesion is outlined accurately, either by radiography or by esophagoscopy. The treatment then proceeds, according to Guisez's or de Nabias' technic. The characteristic unpleasant salivation is usually not relieved, although the production of saliva can be controlled radiologically.

J. G. STEPHENS, M B. (Syd.), D.M.R.E.

**Radium in Superficial Face Lesions.** W. A. Chernosky. *Texas St. Jour. Med.*, December, 1930, XXVI, 573.

The application of radium to superficial lesions of the face is usually a simple procedure, though sometimes tedious when cosmetic results are borne in mind. The operator's skill

may be taxed to destroy a large growth without unnecessary injury to surrounding healthy tissue. In early lesions radium gives good results, with minimum scarring. The use of radium, being harmless and painless, encourages patients to apply early for treatment. If the radium treatment is not successful, surgical measures may be resorted to without detriment to the patient. By combining the two methods, or using radium post-operatively, the percentage of permanent cures may be increased.

W. W. WATKINS, M.D.

**Contribution to the Radium Therapy of the Bleeding Nipple.** Fritz F. Dautwitz. *Strahlentherapie*, 1930, XXXVIII, 710.

The history of two women is related, who were treated with gamma rays of radium 12 and 17 years ago for bleeding nipple. The total doses applied amounted to 20,729 mg.-hrs., given during a period of five years, and 26,950 mg.-hrs. given during three and one-half years. Both patients are still well to-day. In doubtful cases and those in which operation is refused, the author suggests that radium therapy should be given a trial.

ERNST A. POHLE, M.D., Ph.D.

## ROENTGENOTHERAPY

**A Note on the Treatment of Erysipelas by X-rays, with an Account of Three Cases.** R. Hillhouse Jamieson and F. Hernaman-Johnson. *British Med. Jour.*, Jan. 10, 1931, No. 3653, p. 57.

The value of X-ray therapy as an agent capable of cutting short the acute stage of erysipelas, was first advocated by Platau, Schlitz, and Collins. In the present account, the course of the disease in a case treated in the usual way by local applications and serum, is contrasted with two cases treated by the X-ray. In the first case the temperature fell by lysis, and in those treated by the X-ray by crisis, and the improvement in both the local and general condition was dramatic. How these very small doses accomplish their purpose is uncertain, but it would seem to be due to a stimulation of the local and general

resistance. It is not due to any direct destruction of germs.

It is concluded that, as regards crystals, the authors have in the X-ray a powerful weapon which can be confidently recommended in any case which causes anxiety to the doctor or the patient.

WALLACE D. MACKENZIE, M.D.

**On the Question of the Distribution of Roentgen-ray Intensity in the Human Body in Deep Therapy. I.—Critical Review of the Problem and its Principles.** M. Dornreich. *Strahlentherapie*, 1930, XXXVIII, 591.

This is the first of a series of articles dealing with the problem of isodose curves. The literature of the past, concerning the subject, is analyzed and the fundamental principles of the measuring methods are discussed.

ERNST A. POHLE, M.D., Ph.D.

**The Roentgen Treatment of Metastasis to the Vertebrae and the Bones of the Pelvis from Carcinoma of the Breast.** Eugene T. Leddy. *Am. Jour. Roentgenol. and Rad. Ther.*, December, 1930, XXIV, 657.

The author maintains the fact that carcinoma of the breast may metastasize early is not taken seriously enough in clinical practice, for the spine or pelvis may be the seat of trouble for a long time, without other lesions and without symptoms or apparent change in the patient's condition. Hence, the high incidence of skeletal metastasis makes it an important problem for the pathologist, the internist, and the radiologist. The author believes that metastasis from carcinoma of the breast reaches the pelvic and vertebral bones, probably by a combination of aberrant and reflux spreads through the lymphatics, and is often accompanied by an inflammatory reaction of non-infectious origin, the most common symptom being pain in the right sciatic nerve. Treatment by roentgen rays by an effect on both the inflammatory and malignant cells in the metastatic growths, produces analgesia, often complete and of months' duration, and is the best method of palliating

the painless disease. Several tabulations are included in this paper.

J. E. HABBE, M.D.

**A Simple Field Selector in Roentgen Deep Therapy.** Georg Heinrich Schneider. *Strahlentherapie*, 1930, XXXVIII, 762.

This is a description of a simple arrangement which facilitates the selection of fields in roentgen therapy. Its principles consist of a frosted glass plate bearing a co-ordinate system in centimeters. The anatomical cross-sections and isodose curves can be placed under the plate.

ERNST A. POHLE, M.D., Ph.D.

**Roentgen Therapy of the Spine in Skin Diseases.** A. Krynski. *Strahlentherapie*, 1930, XXXVIII, 730.

Gouin has recommended superficial roentgen therapy directed to the spinal region in order to influence certain skin diseases. He uses roentgen rays of little penetration because he wishes to affect only the superficial nerves and not the deeper lying spinal cord. The author employs a modified technic: 150 K.V., 3 mm. Al, 4 H per field (approximately 350 r), 30 cm. F.S.D. Each field is 10 cm. long; the upper area is centered over Th. 2-3, the lower area over Th. 12. Treatments are given at three weeks' intervals. If after three exposures there is no response, an interval of from 6 to 9 weeks is advisable. In conclusion, the author states that this treatment is the method of choice in cases of lichen ruber planus. He also cured two severe cases of dermatitis herpetiformis. Definite improvement was seen in patients with neurodermatitis, eczema, and pruritus. The only reaction following the treatment consisted in sweating and slight nausea on the following day.

ERNST A. POHLE, M.D., Ph.D.

**Radiation Therapy of Thrombophlebitis.** Josef Halban. *Wien. klin. Wchnschr.*, Nov. 6, 1930, XLIII, 1368.

The roentgen treatment of inflammatory diseases has been established since Heidenhain and Fried published their results. The author

used the following treatment in seventeen cases of thrombophlebitis: 180 K.V., 3 ma., a filter of 0.5 mm. Zn and 2 mm. Al, and a distance of 28 centimeters. About 15 per cent of a skin erythema dose was given, and several fields were used when the phlebitis extended over considerable length. The results were very gratifying. The pain, which is often very severe, disappeared shortly after the treatment, the swelling receded rapidly, and the recovery of the patient was hastened. The results were so good that all such cases were submitted to roentgen treatment. One must be very careful in moving a patient and should, if possible, transport him only in his own bed, as lung emboli are always to be feared.

H. W. HEFKE, M.D.

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**Relative Value of Roentgen and Radium Therapy.** R. H. Crockett. *Texas St. Jour. Med.*, December, 1930, XXVI, 578.

Two very elementary but important questions are often asked by referring physicians and patients, *viz.*: "Just what good will X-ray or radium treatment do?" "Which is the better, X-ray or radium treatment?" Without a categorical answer to these questions, the author discusses many conditions in which radium or the X-ray may be used and his usual practice in choosing the type of radiation. The discussion covers fibroids of the uterus, malignancy of the breast (in which he advocates pre-operative and post-operative radiation, the latter including three cycles of treatment), and malignant conditions in general.

W. W. WATKINS, M.D.

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**Deep Roentgen-ray Therapy of Mammary Carcinoma. II.—Five-year Results: Value of the Method as an Auxiliary to Surgical Procedures in the Operable, and as a Primary Procedure in the Inoperable Cases.** William A. Evans and T. Leucutia. *Am. Jour. Roentgenol. and Rad. Ther.*, December, 1930, XXIV, 673.

In 1925, the authors presented their first experiences with deep roentgen therapy in

carcinoma of the breast, giving, in detail, their method of procedure and the technic of irradiation in both the operable and inoperable cases. Analysis showed that roentgen therapy in its new, short wave length application forms one of the most powerful agents in the treatment of mammary carcinoma. In this present article a detailed statistical account is submitted of the five-year results obtained in the previous series. These statistical results are presented in the form of tabulations, there being thirteen.

The authors conclude that roentgen therapy in its short wave length application is of considerable aid in the treatment of operable mammary carcinoma as an auxiliary to surgical procedures. In the cases without glandular involvement, the addition of irradiation does not noticeably increase the five-year results above those of surgery alone. However, in the cases in which the carcinoma has already spread to the axillary or the high thoracic lymph nodes, the five-year results are nearly doubled. The best method of procedure is considered to be a combination of radical surgery, with a systematic irradiation of the entire anterior thorax, axilla, and neck on the diseased side. In the inoperable or recurrent mammary cases, roentgen therapy produces prolongation of life and alleviates the symptoms.

J. E. HABBE, M.D.

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**Our Experience with the Protracted Fractional Roentgen Treatment of Coutard.** A. Kahlstorf and A. Zuppinger. *Strahlentherapie*, 1930, XXXVIII, 199.

Since April, 1929, the authors have treated 52 cases of far advanced malignancies with the method of Coutard. A potential of 170 K.V., filter of 0.45 mm. chrome iron, plus 1.0 mm. copper, plus 1.0 mm. aluminum, giving a half value layer in copper of 1.113 mm., were used. The F.S.D. varied from 60 to 100 cm., while the single dose amounted to about 150 r; treatments were given daily over a period of from three to four weeks. The total doses applied were between 4,800 and 7,200 r, as measured in air.

All cases are discussed in detail, giving the essential parts of the history and the outcome.

Many photographs of patients accompany the article. In spite of the fact that the authors were dealing with advanced cases, they were able to obtain temporary cures in nine cases. The reactions of the skin and of the mucosa following this type of treatment are entirely different from those customarily observed after single heavy doses. These reactions are described in detail and a number of photomicrograms show the histological characteristics. Since this method employs such high total doses, a very careful observation of the reactions is essential in order to prevent acute or latent injuries. In many cases, the regression of the tumors started several days after the beginning of the treatment. Cases with a recurrence did not respond to additional treatment, as a rule. In such patients, it is better, provided the procedure can be carried out, to remove the remaining tumor by electrocoagulation. When treating tumors within the mouth, great caution must be used in order to prevent bone necrosis. The removal of teeth after the treatment is not advisable. Although it is impossible to report end-results obtained with this treatment method, the authors feel that it should be studied further in inoperable cases of neoplasms.

ERNST A. POHLE, M.D., Ph.D.

**Radiation Therapy of Polycythemia Vera.**  
George T. Pack and Lloyd F. Craver. *Am. Jour. Med. Sci.*, November, 1930, CLXXX, 609.

Polycythemia may be functional (altitude, fright, dehydration, etc.) or essential (polycythemia vera). Polycythemia with splenomegaly is the common type, and, in this, irradiation is the treatment *par excellence*. The disease is due to overproduction of the red cells by the bone marrow, and failure of the cell-destroying mechanism of the body to keep pace with production. Polycythemia is a clinical analogue of myelogenous leukemia, and treatment should be directed to the radiosensitive marrow cells. Splenectomy is contraindicated, and radiation is superior to chemical agents. Since the locus of the disease is in the bone marrow, sufficient irradiation should be given to inhibit or depress but not

to destroy erythropoiesis. The dosage must be exact, and will depend on the severity of the illness. The treatment must be carefully controlled by observing the condition of the patient and the number of leukocytes. Both long and short bones may be treated, but particularly the long bones; the head and the pelvis should not be treated, to avoid alopecia and effect on the gonads. The irradiation prevents the formation of new erythrocytes, and is not designed to destroy red cells already formed. The suggestion has been made that stimulative doses should be applied to the spleen to increase cell destruction, but these authors question the value of this. Some interesting case reports are given in detail.

W. W. WATKINS, M.D.

**The Effect of Roentgen Rays on the Eye.**  
W. Rohrschneider. *Strahlentherapie*, 1930, XXXVIII, 665.

The author, who has done a considerable amount of experimental work of his own concerning the effect of radiation on the eye, discusses critically the literature on the subject. He summarizes our knowledge in a tabulation which gives the tolerance and injurious doses for the various parts of the eye, as compared with the epilation dose. It appears that the lens is most sensitive, since an epilation dose represents its tolerance. Conjunctiva and cornea tolerate from 20 to 30 per cent more than the so-called erythema dose. The margin of safety is greater for heavily filtered radiation. In conclusion, the author emphasizes that he does not wish to discourage the use of roentgen rays or radium in diseases of the eye, but merely wishes to draw attention to the fact that caution is necessary in prescribing radiation therapy in ophthalmology.

ERNST A. POHLE, M.D., Ph.D.

**Roentgen Treatment of Hyperthyroidism.**  
Wright Clarkson. *Virginia Med. Monthly*, November, 1930, LVII, 498.

The mortality in surgical treatment of hyperthyroidism has been reduced to 1 per cent in the hands of the best surgeons, but a method which will give as good results as surgery

should be welcome. Reports in medical literature indicate that irradiation is a worthy rival of surgery in treating hyperthyroidism. The very conservative report of Groover, Christie, Merritt, Coe, and McPeak on 305 patients showed more than 88 per cent cured, and only 2.5 per cent unimproved. The author's technic is high voltage, heavy filter, and short exposures at intervals of from ten days to three weeks. Care should be taken to include the thymus in the radiation. The general care of the patient is important, with bed rest for acutely ill patients, removal of foci of infection, and the treatments controlled by frequent basal metabolic tests.

W. W. WATKINS, M.D.

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**Roentgen Therapy of Tabes.** Curt Kresser. *Strahlentherapie*, 1930, XXXVIII, 719.

Forty-four patients suffering from tabes were treated by roentgen rays. The technic is as follows: 180 K.V., 4 ma., 0.5 mm. Cu, 23 or 30 cm. F.S.D., one-third E.D. per field. In the first group, two lateral fields and one posterior field over the spine were given. The total dose in the cord amounted to from 70 to 90 per cent E.D. In the second group, two oblique fields, one to the left and one to the right of the spine, were applied, one-third E.D. per area. The third group received one field directly over the spine, one-third E.D. per treatment. In the fourth group, the technic of the second and third groups were combined. In 11 cases there was no effect at all upon the symptoms, particularly the pain. Four patients were slightly improved, 20 showed a temporary improvement, and only 9 obtained improvement over a longer period. In the opinion of the author, roentgen therapy may, therefore, be used as a symptomatic agent in tabes, but apparently does not influence the pathological process.

ERNST A. POHLE, M.D., Ph.D.

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**The Effect of High Voltage Roentgen Radiation (200 K.V.) upon the Fertility and Motility of the Sperm of the Rabbit.** Sydney A. Asdell and Stafford L. Warren.

*Am. Jour. Roentgenol. and Rad. Ther.*, January, 1931, XXV, 81.

Twenty-two full grown female rabbits were used in these experiments. It has been found that ovulation in rabbits occurs about ten hours after copulation. For fertility studies, does were allowed to copulate with vasectomized bucks. One hour later these does were artificially inseminated with irradiated or control spermatozoa. Sperm for artificial insemination and for motility experiments was obtained by sacrificing a doe which had just copulated with one or more vigorous normal bucks. The abdomen was opened, the semen obtained and immediately divided into two equal portions and placed in two thin petri dishes, one portion being given large amounts of radiation consisting of all the wave lengths in unfiltered or filtered beams of radiation produced at from 100 to 200 kilovolts. Motility studies of the sperm during these experiments gave no indication of any change resulting from the irradiation. Two litters of apparently normal young were obtained by artificial insemination with irradiated sperm.

J. E. HABBE, M.D.

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## SINUSES (DIAGNOSIS)

**Roentgen Examination of the Paranasal Sinuses and Mastoids.** Amédée Granger. *Jour. Am. Med. Assn.*, Nov. 1, 1930, XCV, 1332.

The author, from experimenting and after seven years' practical experience, is convinced that roentgenograms made in other positions do not show the same constant and clear anatomic boundary landmarks for the sphenoids, ethmoids, and paranasal sinuses, as those made by his method described in 1923. For the examination of the mastoid regions, roentgenograms were made in the position recommended by Law, and in the position described by the author in 1926. The Granger roentgenogram gave a more detailed view of the anatomy of the mastoid region and process, with fewer structures superimposed. It showed the different groups of cells, including the tip cells, much more distinctly; the superior semicircular and internal auditory canals;

the sharp outline of the mastoid cortex; and in this view the course of the external auditory canal is away from and does not overlie the shadow of the mastoid cells. Labyrinthitis has been diagnosed in several instances, to be confirmed by the usual otologic tests. A pre-operative diagnosis of tumor of the acoustic nerve was made in two cases. In infants and children under six years of age, the Law position is the only one that can be satisfactorily employed. The author summarizes his observations on an intensive study of roentgenograms of children presented in 1929.

C. G. SUTHERLAND, M.D.

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**Osteoma of the Frontal Sinus.** R. O. Leavenworth. *Laryngoscope*, December, 1930, XL, 885.

The literature up to 1926 shows 117 reported cases of osteomas of the frontal sinus. The tumors are most often encapsulated with a pedicle, but a few are ordinary exostoses. Numerous cases are on record in which the pedicle has become detached, causing what is termed a "dead osteoma." Occasionally there is an associated mucocele, and frequently a complicating acute frontal sinusitis. Osteomas are essentially benign and usually slow-growing, although they may increase their rate of growth and develop in a matter of weeks more than they did in the several previous years. The serious aspects are produced by pressure and encroachment into the cranial cavity and the orbit, as well as the frequent complicating acute frontal sinusitis. The diagnosis is, of course, by the X-ray.

A case is reported, diagnosed by the X-ray, of the exostosis type. The patient was operated on for relief of the frontal sinusitis, but the osteoma was not disturbed. The author has followed the case for seven years, and the growth of the osteoma has been only one-fourth of an inch. The patient is now symptom-free and has been so since the operation for the acute frontal sinusitis. The author does not think the removal of osteomas is usually indicated, as it is difficult to make a couple removal because of frequent origin in the ethmoid cells, and there are many reported cases showing a recurrence with a faster

growth-rate after partial removal. There is further danger in operating because extensive exposure of the dura may be necessary. If there are very serious symptoms from pressure and extension of the growth, extirpation of the osteoma should be attempted, and the prognosis with present surgical methods is good.

H. RUDSILL, JR., M.D.

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**Chronic Antrum Disease.** L. E. Patrick. *Northwest Med.*, July, 1930, XXIX, 307.

Antrum puncture with a trocar, and washing, is the least reliable procedure in making a diagnosis of chronic infection, unless a microscopic examination of the fluid is made. In acute infections it is quite valuable. In chronic disease, puncture, with cytological examination as described by Sewall, is of value. The roentgen ray is the most important single factor in determining the pathology present, but, taken alone, is often misleading. Lipiodol as a contrast medium has not been very successful in the author's hands.

W. W. WATKINS, M.D.

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**The Interpretation of Sinus Roentgenograms.** G. W. Grier. *Am. Jour. Roentgenol. and Rad. Ther.*, July, 1930, XXIV, 21.

The author emphasizes the value of stereoscopic postero-anterior views taken at three angles and supplemented by supero-inferior, lateral, and Granger projections.

Sinus pathology being dependent upon variations in the normal transparency, these densities have been classified as local and general. Localized areas of density may be produced by osteoma, fibroma, polyp, mucocele or cyst, hyperplasia of lining mucous membrane, or malignant newgrowth. Osteomata and fibromata are not as a rule distinguishable. Polypi, mucocelles, and cysts are likewise difficult to differentiate, but here the rhinoscopic findings should assist. The fuzzy or clean-cut appearance of the inner margin of a thickened lining membrane may aid in determining active or la-



tent sinus disease. Post-operative cases, especially antra, often show residual opacities. The only roentgen sign strongly suggestive of malignancy is erosion of bone in the vicinity of the tumor. Generalized densities of one or more sinuses, if pronounced, are usually due to empyema, extensive polyposis, or newgrowth. In differentiating the first two conditions, if there is ethmoid involvement a widening of the ethmoid regions is suggestive of polyposis.

The author has very rarely been able to demonstrate fluid levels in any of the sinuses. Slight uniform densities of the sinuses are observed in congestion of mucous membrane, old thickening of membrane of slight degree, post-operative cases, suppurative sinusitis where the pus is well drained out, and chronic hyperplastic sinusitis. Differentiation in such cases is quite impossible by the X-ray alone, but usually may be accurately made if the history is correlated with the rhinoscopic and roentgenologic findings.

J. E. HABBE, M.D.

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### SINUSES (THERAPY)

The Diagnosis and Treatment of Inflammation of the Maxillary Antrum. Perry G. Goldsmith. Canadian Med. Assn. Jour., October, 1930, XXIII, 512.

In the great majority of instances the mucosal inflammation of the maxillary antrum is caused by acute rhinitis. It is also associated with external violence, operations, abscessed teeth, infection of ethmoids and frontals, septal deflection, and enlarged turbinates as causative factors.

The symptoms of acute antral inflammation are excessive purulent nasal discharge, pain in the face (increased on leaning forward), and some tenderness in the canine fossa. Additional diagnostic agents are transillumination and diagnostic puncture. The X-ray is not needed in the acute cases. The author places great reliance on transillumination. Puncture of the antrum is valuable in the acute cases,

but not so valuable in the chronic cases, where secretion does not always form the main pathologic process.

The treatment of the acute condition depends on its degree. In such cases irrigation should be employed until the secretion becomes more gelatinous, or changes into a lemon-colored mucoid mass. If, however, after some weeks, the nasal or post-nasal discharge still persists, improved facilities for drainage and ventilation should be secured. This is accomplished by enlarging the drainage opening, followed by continued irrigation, and the instillation of neo-silvol or zinc sulphate, or even by ionization, which may be helpful.

The symptoms of chronic antral inflammation consist of chronic discharge, which may be thin and scanty, and of varying degrees of nasal obstruction, due to enlargement of the turbinate mucosa. The patient has frequent head colds, and sneezes.

The pathologic process is of a deeper character than in the acute condition. The deeper structures of the antral mucous membrane are attacked. Cysts are more common. Irregular edematous masses and diffuse hypertrophies are frequent.

The diagnostic measures used in the chronic condition are much the same as in the acute, with the addition of the X-ray. The information required from the X-ray examination pertains more to the character of the mucous membrane. This information is obtained better if the antrum is injected with lipiodol and olive oil (1-3), or bismuth in paroline.

The treatment of the chronic condition consists in attention to the general health, such as change to a warmer climate, and the securing of better nasal ventilation and drainage. These measures may involve straightening of a deflected septum or removal of the anterior end of the middle turbinate. If this does not suffice, increased drainage may be secured by enlarging the exploratory opening and repeated irrigation. If irrigation and ventilation do not effect a cure, the infected antral mucous membrane should be removed entirely through an opening made under the lip through the canine fossa.

L. J. CARTER, M.D.

The Rational Surgical Treatment of Chronic Antral Disease. John G. Hunt. Canadian Med. Assn. Jour., September, 1930, XXIII, 386.

Operations for chronic maxillary sinusitis are now almost as common as those for chronic tonsillitis, thanks to the simplification of the diagnosis by the radiologist. With the advent of iodized oil, preliminary to radiography of the antra, it is now possible to tell at a glance, not only if the sinus is diseased, but also to say with a considerable degree of accuracy the type and degree of pathological change present in the lining mucosa, whether fibrous, polypoid, or purulent. This point is illustrated by five excellent reproductions of radiographs. Chronic maxillary sinusitis plays a large part as a causative factor in "chronic catarrh," chronic eye, ear, and pulmonary conditions, chronic headache, neurasthenia, and arthritis.

The indications for treatment are determined by the type of pathology present. The three types of treatment employed are the intra-nasal, the naso-antral, and the extra-nasal methods.

The intra-nasal method is based on the nasal obstruction theory as the cause of maxillary sinusitis, but fails usually because it ignores the local focus in the antrum.

The naso-antral method has the largest following. It consists in making a drainage opening from the lowest part of the antrum into the nasal cavity. It is of value only when free pus is present, and then often fails. If polypi are present the use of this method is indefensible.

The advocates of the extra-nasal method regard nasal obstruction and high antrum opening as quite irrelevant factors. They feel that, provided the nasal or remote symptoms are such as to demand operative interference, and the X-ray shows considerable increase in the mucosal density, the rational procedure is the complete extirpation of the infected mucosa. To do this it is necessary to have access to all parts of the antral cavity. Adequate approach through the nose being impossible, the simple expedient

of temporarily elevating the buccal mucous membrane and removing enough of the external bony antral wall was adopted.

The modern surgeon does not do the radical operation of complete ablation of the antral cavity, as advised by Caldwell and Luc, the pioneers of this operation. Only sufficient bone is removed to permit the excision of all diseased tissues, and a flap of nasal mucosa is turned into the cavity to provide a nucleus for the subsequent epithelialization. This method gives gratifying clinical results. It should not be used during an acute exacerbation of the infection.

L. J. CARTER, M.D.

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### SKIN (THERAPY)

The Action of Roentgen and Ultra-violet Rays on the Reticulohistiocytic System of the Skin. Pietro G. Castellino. *Archivio di Radiologia*, July-October, 1930, VI, 681.

The author irradiated the backs of rabbits, with single varying doses of roentgen and ultra-violet rays, injected a vital stain (trypan-blue), and examined specimens from the fields irradiated at varying intervals. He found, histologically, a difference in effect, due, probably, to the difference in quality (penetrability) of these two types of radiation and the doses used.

E. T. LEDDY, M.D.

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The Need of More Conservative Roentgen Dosage in Skin Disease. W. F. Spiller. *Texas St. Jour. Med.*, December, 1930, XXVI, 582.

The author discusses some unfortunate results often seen following radiation of the skin, and believes the remedy is in the more careful and conservative use of the X-ray. In benign conditions, he follows the MacKee technic of fractional skin doses. In malignant skin lesions he is opposed to massive doses, and thinks it is better to give second doses than to over-treat. He thinks that an accurate diagnosis should precede the use of the X-ray, that

the least amount of X-ray necessary for a good result should be used, that if a case does not respond well to X-rays some other method should be substituted, and that it is better not to use X-rays at all than to produce a radiodermatitis.

W. W. WATKINS, M.D.

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**Multiple X-ray Carcinomas Following Psoriasis: Case Report and Comment.** Herman Goodman and Charles W. Price. *Arch. Phys. Ther., X-ray, Radium.* May, 1930, XI, 209.

This is a case report in which an examination revealed typical psoriatic patches over the extensor surfaces of the extremities and on the back. In addition, there was a radiodermatitis of the psoriatic regions of the arms and legs (120 square inches of radiodermatitis). Pathologic study from a section of an ulcer of the dermatitis showed it to be prickle-cell epithelioma. The psoriatic lesions developed 28 years ago. Six years ago the lesions were cleared up by twelve X-ray exposures. Shortly, the lesions reappeared and the patient received further X-ray exposures every 7 to 14 days for over a year. The disease became worse and ulcerated six months ago.

Arthur Alexander reported 18 cases of carcinoma on the basis of pre-existing psoriasis, 11 as arsenical carcinomas, and 7 as pure psoriasis carcinoma. This would indicate a feature of unrest in a psoriatic skin. MacKee has said that if psoriasis does not clear up after three treatments of one-fourth skin unit per week, that some other treatment should be instituted. From the authors' preliminary work it seems that an over-radiated skin can be detected early by filtered ultra-violet light.

HERMAN GOODMAN, M.D.

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### SKULL (DIAGNOSIS)

**The Technic of Encephalography.** Carl D. Camp and R. W. Waggoner. *Arch. Neurol. and Psychiat.*, January, 1931, XXV, 128.

The authors state that there are two profound objections to encephalography: First, the severe reaction which the patient experi-

ences during and after the injection of air; second, the danger of this procedure in cases with increased intracranial pressure. To overcome part of this unfavorable reaction which is dependent, to some extent, upon the amount the patient is moved, they describe a new chair which permits the patient to occupy the horizontal position during the puncture. The chair may also be so adjusted as to allow the patient to rest in the vertical position. It is described in detail, as is also a combination tube-stand and Bucky diaphragm.

C. G. DYKE, M.D.

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**Calcification of the Cerebral Falx.** Giovanni Balestra. *Archivio di Radiologia*, July-October, 1930, VI, 731.

The author reports two cases showing, respectively, a large isolated area of ossification and multiple calcifications of the falx. He gives points of differentiation between the roentgenologic findings in ossification (osteomas) and granular calcification. He emphasizes the importance that granular calcifications have in regard to isolated osteomas, especially if they are not limited to the falx.

E. T. LEDDY, M.D.

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**Intracranial Calcification, with Particular Reference to that Occurring in the Gliomas.** Cyril B. Courville and Leo J. Adelstein. *Arch. Surg.*, November, 1930, XXI, 801.

The literature in regard to intracranial calcification of various kinds is quite well covered, and it is shown that calcareous deposits may be found in practically every type of primary intracranial new growth, with the exception of the craniopharyngeal cysts. It is probably most common in the gliomas. This calcification is of considerable value in the roentgenographic examination of the skull, as the distribution of the calcareous material is usually evenly spread throughout the tumor tissue and gives some conception as to its size and relationship. There may be such a small amount of calcification present that it is not shown on the roentgenogram. Roentgen examination usually reveals an associated thinning of the skull over the tumor, indicating a

local, rather than a general, increase in pressure.

Twelve cases are reported. Of the ten growths verified histologically, five proved to be neuroglia-blastomas, three were astrocytomas, one was an ependymal glioma, and one, an unclassified glioma, apparently a cerebral medullo-blastoma.

HOWARD P. DOUB, M.D.

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**Congenital Cerebral Cysts of the *Cavum Septi Pellucidi* (Fifth Ventricle) and *Cavum Vergae* (Sixth Ventricle): Diagnosis and Treatment.** Walter E. Dandy. Arch. Neurol. and Psychiat., January, 1931, XXV, 44.

The author calls attention to the anatomical relations of these two structures, and reports two cases in which the *cavum septi pellucidi* and *cavum vergae* were markedly dilated with fluid. This was proved by operation. He states that separation of the anterior horn and body of the lateral ventricles, as seen in the ventriculogram, is pathognomonic of the condition. Reproductions of the ventriculograms of these cases accompany the article.

C. G. DYKE, M.D.

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**Traumatic Pneumocephalus.** S. W. Miller, R. N. Klemmer, and P. O. Snoke. Jour. Am. Med. Assn., Jan. 17, 1931, XCVI, 172.

One case is reported because of the great damage sustained by the cerebrum, with at least temporary infection, the associated introduction of air into the ventricles, operation, and complete recovery.

In 1926, Dandy reported three cases of intracranial pneumatocele and, in reviewing the literature, found twenty-five other cases. Of these twenty-eight patients, eight definitely had air in the ventricles. In several others there was considerable doubt as to the location of the air. Observers, in explaining the mechanics of the introduction of intraventricular air, presupposed valve action, permitting egress of fluid and ingress of air. Dandy believes an additional factor, such as sneezing, coughing, straining, or even swallowing, is necessary to

force the air from a sinus through rents in the bone and dura into the brain proper.

The important instructive features of the case were: (1) Increasing headache, in a patient with fracture of the skull, should call for roentgenographic re-examination; (2) patients with fracture of the skull involving a sinus should be instructed never to blow the nose; (3) cerebrospinal fistula usually demands operative intervention; (4) the roentgenogram is diagnostic.

CHARLES G. SUTHERLAND, M.D.

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**Hypophyseal Lacunar Dysostosis.** Mario Santoro. Archivio di Radiologia, July-October, 1930, VI, 713.

The author describes the case of a boy who had diabetes insipidus. On roentgen examination of the sella turcica, he found a lesion (illustrated in the article) in the cranial bones and similar ones in the ribs, pelvic bones, left humerus, and both femurs. They were at first thought to be due to faulty calcium metabolism secondary to the pituitary lesion, but further examination demonstrated active pulmonary tuberculosis, which the author regards as the most probable cause of the bone changes.

E. T. LEDDY, M.D.

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## SPINE (DIAGNOSIS)

**Roentgenologic Findings in a Series of Seventy-two Cases of Traumatic Myelitis Due to Fracture of the Spine.** E. S. Gurdjian. Am. Jour. Roentgenol. and Rad. Ther., January, 1931, XXV, 65.

Although at times very difficult to obtain, the author believes that roentgenograms of all cases of acute spine fractures should be made before any operative procedure is considered. It is important to have good lateral films, being particularly careful, when studying the cervical region, to include the seventh cervical and first dorsal vertebrae. The majority of the cases described had injury at the lower cervical, lower dorsal, and upper lumbar levels. Compression fracture of the cervical vertebrae is not infrequent, and several instances of this

type are described. Longitudinal fracture through the bodies of the vertebræ is a possibility and can be diagnosed from the roentgenogram. The involvement of the spinal cord in fractures of the spine may be either direct or indirect. In the series presented, central softening and hematomyelia were found most frequently in fractures in the cervical region. Edema of the cord after injury is a definite pathologic entity, and is probably responsible for excessive destruction of cord substance. The author concludes that it would, however, be a grave mistake to depend upon roentgen examinations alone.

J. E. HABBE, M.D.

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**Double Isolated Compression Fracture of the Spine.** Chester C. Schneider. *Jour. Bone and Joint Surg.*, July, 1930, XII, 595.

The author states that there have been only twelve reported cases of multiple compression fracture. He adds three more cases which have followed serious accident, and in all of these the involvement is in the thoracic column.

PAUL C. HODGES, M.D.

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**Disabling Back Pain: Differential Diagnosis and Treatment.** Robert McE. Schaufli. *Jour. Am. Med. Assn.*, Dec. 6, 1930, XCV, 1717.

In considering disabling back pain one must be sure there is no gross lesion, such as a compression fracture of a vertebra or a fracture of the transverse or spinous processes, destructive bone lesion, such as tuberculosis or cancer, or root pain from locomotor ataxia, tumor, or other lesion of the spinal cord. Reflex pain, due to disease or displacement of some viscus, malingering, or a psychoneurosis must be ruled out. Good roentgenograms, both antero-posterior and lateral, will give definite information. Asymmetry of the spine alone is seldom the cause of pain. An increase of the lumbosacral angle might cause chronic strain and pain. Occasional cases of true spondylolisthesis are revealed. The displacement is usually between the fifth lumbar ver-

tebra and the sacrum, or it may be between the fourth and fifth lumbar vertebræ. It must be apparent in the lateral roentgenogram to justify the diagnosis. Congenital malformations of the spine may be puzzling as to whether or not they are the cause of the back pain. Misshapen vertebræ usually lead to deformity early in life, the patient having an abnormal curve of the spine for years. Spina bifida occulta is seldom a cause of back pain. Complete sacralization of the fifth lumbar transverse processes rarely causes symptoms. Unilateral sacralization of the fifth lumbar transverse process is more likely to cause pain because of the unbalance of the spine. Impaction of the transverse process of the fifth lumbar vertebra is seldom a cause of pain. In middle aged or old persons, the roentgenogram often shows hypertrophic arthritis, with rims or spurs in the more advanced cases. One has quite a problem to decide whether or not these changes are the cause of pain.

Comparative data in different series of patients, giving the numbers in which the roentgenographic findings were positive and diagnostic, and in which they showed lesions considered only coincident, are instructive. When there is doubt as to the interpretation, the spine should be immobilized and new films should be made after a two months' interval. The necessity for correlation of a carefully elicited history and comprehensive observation with the roentgenographic findings is stressed.

Treatment is reviewed in all its phases. If other conditions improve but the low back pains remain at the end of six months, hysterectomy in women, and mobilization of the cecum in both sexes, is indicated.

CHARLES G. SUTHERLAND, M.D.

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**Spondylolisthesis.** Henry W. Meyerding. *Jour. Bone and Joint Surg.*, January, 1931, XIII, 39.

The author summarizes the findings in 121 cases of spondylolisthesis seen at the Mayo Clinic in the last twelve years. Trauma was a factor in 40 per cent of the cases in which two-thirds were males. Roentgenograms are considered essential aids in making a diagno-

sis. It is practically never possible to reduce the deformity even when it has been caused by recent injury, but the symptoms are relieved by immobilization either by means of belts or by surgical fusion of the lower lumbar vertebrae and the sacrum.

PAUL C. HONGES, M.D.

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The Roentgenogram of Spondylitis Typhosa. Julian Arendt. *Röntgenpraxis*, Dec. 1930, II, 1080.

The spondylitis which follows typhoid is a rather rare disease, only about one hundred cases having been published in the literature. The roentgenologic appearance is dependent on the severity of the lesion and may easily be mistaken for tuberculosis of the spine. Changes in the intervertebral discs and areas of destruction in the vertebrae are commonly seen in a "typhoid spine." Abscesses are not present around the area of infection, the localization usually being in the lumbar spine.

H. W. HEFKE, M.D.

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### THYMUS (DIAGNOSIS)

Roentgenology of the Thymus in Infancy and Differential Diagnoses of Enlarged Thymus and its Treatment. Henry K. Pancoast. *Am. Jour. Med. Sci.*, December, 1930, CLXXX, 745.

This is a very comprehensive article in which the stand is taken that the size of the gland is not the important factor but the thymic menace in infants is largely a matter of tracheal stenosis, aided by relaxation of the soft tissues of the upper respiratory tract. The roentgenologic evidences of thymic enlargement are often erroneous, the only reliable sign of an enlarged or dangerous gland being the buckling of the trachea at the thoracic inlet as it passes over the apex of the gland. This is shown only in a lateral view of the chest, and in the lateral deviation of the trachea in the sagittal view. Unusual width of the shadow is of no particular significance.

Accurate studies of the chest and upper respiratory tract of infants and young children

must be based on two important factors, namely, a uniform and comprehensive technic capable of being reproduced in every instance, and in normal standards for different ages. The technic is described in detail for the taking of films in the erect and horizontal positions, in both sagittal and lateral views. It is essential to examine all thymic suspects in two phases of respiration, if any comparative measurements are to be made. Differential diagnosis is important, and this must not be overlooked just because an enlarged thymic shadow is found. The following conditions have been found in patients suspected of having thymic symptoms: foreign bodies, retropharyngeal abscess, tracheal and laryngeal stenosis, adenoids, asthma, whooping cough, meningitis, congenital heart conditions, congenital atelectasis, collapse of soft tissues, and recurrent laryngeal paralysis.

In the treatment of the gland by irradiation, we are dealing with a lymphatic structure which is extremely susceptible to irradiation, and only sufficient dose should be given to reduce the gland to a safe size. In very early infancy from one-tenth to one-fourth of a mild erythema dose should be given, at 130 K.V., 5 mm. aluminum, nine-inch skin distance, with a slightly larger dose for older children.

W. W. WATKINS, M.D.

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Roentgen Diagnosis and Treatment of Enlargement of the Thymus. Eugene P. Pendergrass. *Pennsylvania Med. Jour.*, September, 1930, XXXIII, 860.

There are certain definite and well founded facts concerning the thymus which are not sufficiently well known and which deserve consideration. The author concurs in the views of Jackson that thymic menace is largely one of tracheal compression. Any roentgenologic technic undertaken in the study of the thymus must include the upper respiratory tract, and also a preliminary fluoroscopic study in essentially the same positions as the roentgenographic views. Sagittal views are made on a low table, with the infant prone upon the cassette. The tube distance is 38 inches and directly over the suprasternal notch. One attendant holds the lower extremities and hips;

another holds the upper extremities above the head, which must be exactly straight, without the slightest rotation to either side and midway between flexion and extension. Exposures can be made in 1/20 sec. and 100 ma. or faster if desired. One exposure is made during expiration and one during inspiration, the child being made to cry for the sake of deeper inspiratory effort. An exact lateral view is also required, the arms being held downward and back, the shoulders thrown as far forward as possible. Use twice the exposure above mentioned, also during expiration and inspiration.

As a result of some experimental work, the author concludes that exposures should also be made in the erect position, an adaptable chair having been devised for this purpose.

In considering radiation therapy of the thymus, it is recalled that the gland is extremely susceptible to radiation, symptoms of enlarged thymus sometimes disappearing after an ordinary X-ray examination. Another important observation, not always remembered, is that the gland can regenerate in from five to ten days. Conservative treatment is advocated, giving from  $\frac{1}{3}$  to  $\frac{1}{4}$  of an erythema dose over the thymic region, and not repeating unless the symptoms either do not disappear or return. An interval of ten days is allowed between treatments and rarely are more than four treatments required. The factors employed are: 130 K.V., 5 ma., 10 in. distance, 4  $\times$  4 in. portal, 5 mm. Al filter, 3 to 4 min. time. Roentgen therapy is almost a specific for enlarged thymus, and if the symptoms do not disappear after several treatments, search should be made for some other cause.

W. W. WATKINS, M.D.

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Thymus. Douglas D. Martin. *Southern Med. Jour.*, July, 1930, XXIII, 625.

The size of the thymus has no relation to the severity of symptoms. The thymus is variable in size, not only in different types of infants, but in the same infant at different times. There is a temporary enlargement of the thymus due to intercurrent diseases. The size of the thymic shadow varies with inspi-

ration and expiration. This author believes that we rarely see cases which require X-ray treatment, and the presence of respiratory stridor, with enlarged thymic shadow, is not sufficient indication for X-ray treatment, without further clinical study.

W. W. WATKINS, M.D.

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### TUBERCULOSIS (DIAGNOSIS)

The Clinical Picture of Calcification of the Mesenteric Glands. Hans Rothmann. *Med. Klinik*, Oct. 24, 1930, XXVI, 1596.

In some cases admitted on account of kidney and stomach symptoms, a calcification of the mesenteric glands could be demonstrated as the cause of the symptoms. All cases showed allergy towards milk and a positive skin reaction with bovine tuberculin. The roentgen examination showed calcification of the mesenteric glands. These findings led to a diagnosis of an old infection of the mesenteric glands with bovine tuberculosis.

H. W. HEFKE, M.D.

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Clinical and Radiologic Observations on Tuberculous Lobitis. Pietro C. Malugani. *Archivio di Radiologia*, July-October, 1930, VI, 763.

The author reports eight cases of tuberculous lobitis involving the right upper lobe and two involving the left upper lobe. This type of pulmonary tuberculosis is easily recognizable by (1) the opacity of the whole lobe, and (2) the sharpness of its outline, which follows the course of the line of the fissure.

E. T. LEDDY, M.D.

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Important Factors in the Study of Childhood Tuberculosis. Stuart Pritchard. *Journal-Lancet*, Sept. 1, 1930, L, 421.

This article is devoted chiefly to a discussion of the importance of contact and the use of tuberculin. Prevention of the disease is augmented by the tuberculin test, repeated physical examination, and X-ray studies. The X-ray is in reality internal inspection and a necessary part of a complete physical examination. Calcification is an excellent sign that

the child has at one time overcome at least a part of his infection, but it is not always evidence of inactivity. All children reacting to tuberculin should have serial X-ray examinations in order to anticipate developing lesions.

W. W. WATKINS, M.D.

**Radiographic Aspects of Laryngeal Tuberculosis.** Lorenzo Feci and Luigi Pietrantoni. *La Radiologia Medica*, August, 1930, XVII, 987.

The conclusions drawn by the author are as follows:

(1) The lateral projections give a clear image of the laryngo-tracheal tube.

(2) In non-laryngeal tuberculosis, the larynx presents early ossification or disseminated zones of calcification.

(3) Radiologically, tuberculosis of the larynx presents: (a) zones of irregular rarefactions of granular or amorphous character and blurred contours in cases of cartilage destruction; (b) in chronic processes there are definite opacities which obscure the normal structure of the trachea.

(4) There is no definite radiological picture which radiologists may use to diagnose the type of pathology involving the larynx. The only information which can be obtained is the extent and the shape of the lesion.

(5) Radiological control in tuberculosis of the larynx has very little value when compared to laryngoscopic examination.

L. MARINELLI.

**Differential Diagnosis of Pulmonary Tuberculosis, Lung Abscess, and Bronchiectasis.** F. P. McNamara. *Jour. Iowa St. Med. Soc.*, September, 1930, XX, 421.

In making such a diagnosis, we utilize the facts derived from a systematic clinical history, a complete physical examination, supplemented by properly directed X-ray and bronchoscopic studies, and by adequate laboratory tests. Too often a history is carelessly taken, a perfunctory physical examination made, laboratory tests neglected, or physicians seem to think it is the X-ray machine rather than the trained radiologist that makes the

diagnosis. From physical findings alone, it is highly improbable that an exact diagnosis can be made, and the other diagnostic aids must be depended upon. The X-ray is of the greatest value, and no diagnosis of lung disease is complete unless checked by the X-ray examination. The long controversy as to whether the X-ray or the clinical findings are the more certain, has no place to-day: a diagnosis is made on all the evidence obtainable. The X-ray will show the location of the lesion, whether it is unilocular or multilocular, whether there is cavity formation, with fluid or air, whether tuberculosis alone is present, or whether it is co-existent with another infection. In ruling out a bronchiectasis, the use of iodized oil may be necessary.

W. W. WATKINS, M.D.

**The Differential Diagnosis of the First Stages of Tuberculosis.** Hans Steininger. *Röntgenpraxis*, Dec. 15, 1930, II, 1105.

Since Assmann and Redecker described the so-called infraclavicular infiltrate, cases have been described which showed a round, homogeneous shadow, especially in the infraclavicular region, as the first manifestation of a lung tuberculosis. The clinical findings are often uncertain and tubercle bacilli cannot always be demonstrated. It would be wrong to always call such infiltrations tuberculosis, as bronchopneumonias and grippe may produce the same picture. These difficulties are shown on repeated X-ray examinations.

The author concludes that it would be erroneous to diagnose a tuberculosis from such findings, in the face of uncertain clinical symptoms.

H. W. HEFKE, M.D.

**The Significance of Advanced Tuberculous Infection of School Children.** Eugene L. Opie. *Jour. Am. Med. Assn.*, Oct. 18, 1930, XCV, 1151.

Within the past five years, extensive studies have demonstrated the widespread occurrence of grave tuberculous lesions in the lungs of children who do not seem to be sick, and, in many instances, are well nourished and appar-



ently in robust health. These children do not have the symptoms or physical signs usually associated with pulmonary tuberculosis. Tuberculous infection is discovered by the tuberculin test, and roentgenologic examination furnishes a measure of its severity by revealing the extent and character of the lesions. These studies have shown that the transition from latent to clinically manifest disease is often defined with much difficulty, and that some latent lesions are more extensive than those accompanied by symptoms and physical signs. A survey undertaken to discover tuberculosis in children of the public schools and the data from this are reviewed and discussed.

Routine roentgenologic methods are insufficient. Roentgenologic examination applied to the recognition of latent or clinically manifest lesions in children well enough to attend school requires methods specially adapted to examination of the chest, and the interpretation of films demands experience, together with intimate knowledge of the nature and clinical course of the disease. The application of roentgenologic methods to the examination of school children is costly.

In the search for tuberculous infection, two proceedings are available: (1) Examination by tuberculin tests and roentgenologic examination of all children known to be exposed to open tuberculosis; this method would be effective in proportion to the success of tuberculosis registration; (2) roentgenologic examination of school children who react to tuberculin, precedence being given to groups of children, such as adolescent girls and negro children, among whom the disease is known to be unusually frequent.

C. G. SUTHERLAND, M.D.

**Tuberculosis of the Intestine: Its Differential Diagnosis.** J. Arnold Bargaen. *Minnesota Med.*, July, 1930, XIII, 457.

There are two main types of tuberculosis of the intestine, namely, the ulcerative and the hypertrophic. The hypertrophic types must be distinguished from malignancy, actinomycosis, and non-tuberculous pyogenic granuloma. The roentgenogram shows a filling defect, not unlike that of a malignant

lesion, but usually larger. The ulcerative must be distinguished from chronic ulcerative colitis, amœbic ulceration, diverticulitis, polypoid, and malignant disease. The typical X-ray appearance is deformity in the cecum and ascending colon. There is not the immense thickening of the wall common in chronic colitis, and a tendency to persistence of haustra. Writhing and rapid filling and emptying of the ileocecal coil are seen under the fluoroscope. Amœbic ulceration may afford a real diagnostic difficulty, requiring other aids than X-ray for differentiation.

W. W. WATKINS, M.D.

**Suspected Juvenile Tuberculosis: Evaluation of Clinical Symptoms and Signs.** Frederick Eberson, Jessie P. Delprat, and Ernst Wolff. *Am. Jour. Dis. Child.*, October, 1930, XL, 753.

In a series of 306 children with suspected juvenile tuberculosis, the authors found that there was little or no difference between a group with positive and a group with negative tuberculin reactions, as judged by nine symptoms and ten clinical signs. The greatest difference between the two groups seemed to be in terms of nine roentgen observations that were studied. The roentgen observations listed in order of their occurrence, in cases with a positive tuberculin reaction, were: hilum calcifications, increased markings, enlarged bronchial lymph nodes, thickened interlobar pleura, peribronchial infiltration, calcified bronchial lymph nodes, primary focus, thickened apical pleura, and parenchymal tuberculosis.

The evidence presented showed that the commonly accepted clinical signs and symptoms have no diagnostic significance, except as they may be correlated with roentgenograms and tuberculin tests when these are definitely positive for tuberculosis. As a diagnostic criterion, roentgenograms in conjunction with tuberculin tests were unquestionably of value.

According to McPhedran, calcification of the lymph nodes can be recognized only as shadows having a granular appearance. The increase of perihilar shadows is due, not to

enlargement of bronchial nodes, but to pulsation and vibration of the arteries.

Roentgen observations presented the most favorable picture regarding differences between groups with positive reactions to tuberculin and those with negative reactions. However, in relation to the distribution of symptoms and clinical signs, in terms of the more important roentgen evidence, such differences did not exist.

F. B. MANDENVILLE, M.D.

**The Roentgenologic Diagnosis of Tuberculosis of the Suprarenals.** R. Schatzki. *Röntgenpraxis*, Dec. 15, 1930, II, 1130.

Eighty per cent of all cases of Addison's disease have tuberculosis as an etiologic basis. The roentgenologic demonstration of calcified foci of tuberculosis in the adrenals has, heretofore, been described but once, to the author's knowledge. A patient with Addison's disease, whom the author examined, presented definite and marked calcification in both adrenals, so marked that even the anatomical shape of the adrenals was apparent. Calcification may otherwise be shown only in tumors of the adrenals. A few such cases have been described.

H. W. HEFKE, M.D.

**The Childhood Type of Tuberculosis.** Eugene F. Johnson. *Minnesota Med.*, September, 1930, XIII, 613.

Much is being written on the relation between adult and childhood tuberculosis. This paper presents some illustrative cases from the Nopeming Sanatorium. Childhood tuberculosis is the result of a primary infection with the tubercle bacillus and the initial lesion may be anywhere in the lung. Adult tuberculosis is the result of re-infection and the lesions are usually at the apices and along the pleura. The associated tracheobronchial lymph nodes are always involved in the childhood type, while in the adult they are not involved except in the terminal stages. Caseous lesions in the primary type become encapsulated or calcified, whereas, in the adult type they excavate or fibrose, or both. In the childhood type, infiltrative areas commonly resolve, with little evidence, while in the adult

type infiltrated areas resolve, with production of fibrous tissue. These changes are shown by X-ray examination and must be borne in mind in interpreting X-ray densities.

W. W. WATKINS, M.D.

**Hyperplastic Tuberculosis of the Duodenum and Terminal Ileum.** John Day Garvin. *Jour. Am. Med. Assn.*, Nov. 8, 1930, XCV, 1418.

Hyperplastic tuberculosis of the terminal lower ileum alone, without co-existent involvement of the cecum, is extremely rare. Involvement of the duodenum in the same process has hitherto never been reported. In the case cited here, previous roentgenographic, physical, and proctoscopic examinations were negative in their findings. In August, 1929, the barium flowing into the terminal ileum showed evidence of lack of spasticity or filling and emptying phenomena. To the palpating hand it presented a definite, infiltrated, thickened wall simulating a rope. One month later examination of the stomach gave evidence of obstruction and retention. At operation, tuberculosis of the terminal ileum and involvement of the duodenum with a similar type of lesion, were found. Resection could not be done and subsequent microscopic evidence was not obtained.

In the discussion Reynolds stated that he had found two cases of tuberculosis of the duodenum in the literature, one of which was proved at autopsy.

CHARLES G. SUTHERLAND, M.D.

**The Early Roentgen Diagnosis of Pulmonary Tuberculosis.** Leon J. Menville. *New Orleans Med. and Surg. Jour.*, December, 1930, LXXXIII, 370.

When a pulmonary tuberculous lesion has reached such a size as to produce clinical symptoms, it is susceptible of being visualized on the X-ray film. The roentgen ray is the best single method at our disposal in the diagnosis of early pulmonary tuberculosis. Its accuracy is entirely dependent upon a good technic and a competent and experienced roentgenologist. A complete physical exam-

ination, with a careful history, should be obtained in every case suspected of pulmonary tuberculosis before being sent to the roentgenologist, and consultation should be the rule between the internist and the roentgenologist.

W. W. WATKINS, M.D.

### TUBERCULOSIS (THERAPY)

Sun and Occupational Therapy for Surgical Tuberculosis Patients without Means. A. Rollier. *Strahlentherapie*, 1931, XXXIX, 213.

The author briefly describes in this article the international clinic shops which permit an occupation of the tuberculous patients during their stay in the Sanatorium. Even cases of spondylitis can do some work, as is illustrated in an accompanying picture showing a man lying in his bed on his stomach while using an electric drill placed near the head of the bed. This new development facilitates the return of the cured patients to the home and community as self-supporting citizens.

ERNST A. POHLE, M.D., Ph.D.

The Present Status and Importance of Deep Roentgen Therapy of Tuberculosis of the Lungs. H. Schulte-Tigges. *Röntgenpraxis*, Nov. 1, 1930, II, 983.

The animal experiments, clinical experience of others, technic, and indications for roentgen therapy of tuberculosis of the lungs are reviewed. Two hundred eighty-six patients have been treated during the last ten years, and the end-results seem very favorable and are much better than the results achieved by other sanatoria which do not use roentgen treatment. Careful selection of the patients, small doses of X-rays, and continued supervision of the patient are essential for a successful roentgen therapy.

H. W. HEFKE, M.D.

Phrenic Nerve Operations in Pulmonary Tuberculosis: Results in Five Hundred Cases. E. J. O'Brien. *Jour. Am. Med. Assn.*, August 30, 1930, XCV, 650.

This is a review of the results in five hundred cases. Three hundred and seventy-eight were operated on for cavitation: in 50.5 per

cent the cavities closed, and in 31.2 per cent they became smaller. Results proved more effective in moth-eaten cavities and in those with soft walls, especially the smaller ones. The best results were obtained with cavities at the base of the lung. In many instances the results of phrenicectomy were beyond expectations.

The combination of artificial pneumothorax and phrenicectomy was especially effective in accomplishing closure of cavities in the author's series.

In a series of tables, the results are tabulated in their different phases. Phrenicectomy is not an operation to be considered lightly. The results, however, are sufficient to warrant its more extensive use.

CHARLES G. SUTHERLAND, M.D.

The Limitations of Heliotherapy in Pulmonary Tuberculosis. Bernard Langdon Wyatt. *Ann. Int. Med.*, October, 1930, IV, 376.

Heliotherapy, as defined by the writer, means the direct exposure of the surface of the body to the direct rays of the sun, although indirect effects will be produced by sky reflection and from air currents.

Patients with the so-called "surgical" forms of tuberculosis were not included in the series since the lung involvement is usually minimal, with a tendency to become quiescent rapidly. The number of patients showing appreciable improvement that might be attributed solely to direct heliotherapy was negligible.

The results derived from direct heliotherapy in pleural tuberculosis were most gratifying. Very satisfactory results were secured in tracheobronchial lymph-node involvement. The author believes that heliotherapy is of great value in preventing intrapulmonary extension from hilum tuberculosis, and quotes Mayer, of Saranac Lake, as follows: "When I think of extra-pulmonary tuberculosis I immediately think of light. On the other hand, when I think of pulmonary tuberculosis, I do not think of light. . . ."

C. H. DEWITT, M.D.

**Tuberculous Spondylitis: Its Clinical Symptoms and Curative Results Following Sunlight and Fresh Air Treatment.** Eugen Kisch and Hans Berger. *Strahlentherapie*, 1930, XXXIX, 109.

The authors report in this paper the results obtained in tuberculous spondylitis at the Tuberculosis Sanatorium of the City of Berlin. Of the 563 patients suffering from spondylitis which were seen during the past ten years, 94 (or 16.7 per cent) had paresis. In the majority of the cases, three or more vertebrae were diseased. Fifty-one of the patients (or 54.3 per cent) were cured clinically and roentgenographically. Twenty-three (24.5 per cent) were considerably improved and could be discharged; ten (10.6 per cent) had to be discharged unimproved mainly because of financial or social reasons; ten (10.6 per cent) died during the treatment. The average duration of treatment for the 51 cured cases was nineteen months.

ERNST A. POHLE, M.D., Ph.D.

## TUMORS (DIAGNOSIS)

**A Case of Perithelioma of Fascial Origin, with a Direct Antecedent History of Trauma.** T. Valentine Cooper. *Lancet*, Dec. 6, 1930, CXIX, 1234.

The tumor in this case was interesting because of its unusual histological appearance and because of its close relationship to a previous injury. The patient was a woman, aged 58, who had been struck near the elbow-joint. A lump appeared immediately after the injury. She was able to use her arm, but as the lump enlarged to the size of a pear, and numbness and anesthesia over the distribution of the ulnar nerve appeared, with wasting of the innervated muscles, a piece of the mass was removed under general anesthesia for microscopic examination. A preliminary diagnosis of fibrosarcoma was made and the arm was amputated. From the section, the tumor apparently had its origin in the fascial intermuscular sheaths or septa. Microscopically, the section had the appearance of a tumor which has been classified as a perithelioma, in accordance with current teaching, although

the author believes that on further investigation it seems probable that such a classification rests on very insecure and unscientific foundations. He suggests the name "perivascular sarcoma" for the tumor described, for this name gives a definite indication of the histological appearance, and does not produce confusion regarding the site and mode of origin.

H. J. ULLMANN, M.D.

**Giant-celled Tumor of the Upper Jaw.** H. W. Coates. *Can. Med. Assn. Jour.*, May, 1930, XXII, 681.

This is a case report of a patient thirty-eight years of age. The tumor had been removed ten years previous to the date of this report. In size it was one and three-quarter inches by three-eighths of an inch. It was situated on the right upper alveolus and attached by a pedicle connected with the interior of the antrum through a perforation. The affected part of the superior maxilla was removed radically. The pathological report was giant-cell sarcoma.

At this date, ten years after the operation, the patient is well, and there is no evidence of the return of the growth.

L. J. CARTER, M.D.

**The Diagnosis of Tumors Involving the Spinal Cord.** Henry W. Woltman. *Jour. Am. Med. Assn.*, Nov. 8, 1930, XCV, 1398.

This essay reviews the diagnosis, which is the phase of particular interest to medical men and which has, as its natural sequence, proper treatment. The patient's story is the most important step in the diagnosis. The earliest and commonest complaint is pain. The pain may be in the spine at the site of the tumor; it may be referred to the lower extremities even when the tumor lies high in the canal, but usually it is referred along the distribution of a posterior root, when it is known as a root pain. Root pains are segmentally distributed. The pain becomes more and more intense as tumors grow. Anything which suddenly increases the pressure of the spinal fluid aggravates the pain. Root pains have a habit of awakening the patient from sleep at 3 or 4 o'clock in the morning. Disturbances of

motility are evidenced in a slowly progressive weakness; the muscles become atrophied, weak and toneless, and their reflexes become correspondingly feeble. Disturbances of sensibility and sphincteric control add to the discomfort of the patient.

Roentgenography occasionally reveals erosion of bone produced by a tumor, or even a calcified tumor itself. It is also one of the most certain methods of excluding metastatic tumors and other diseases of bone. The introduction of an opaque medium, such as iodized oil, into the subarachnoid space through cisternal or lumbar puncture, usually does not help a difficult situation. Its use in differential diagnosis is limited and the preparations commonly used are somewhat irritating to the meninges. Differential diagnosis may be difficult. A discussion of the simulants follows. Repeated examinations may be necessary in order to establish a diagnosis. Exploration without definite indication of the correct level of disturbance is almost certain to result in disappointment.

CHARLES G. SUTHERLAND, M.D.

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Changes in the Kidney Pelvis on the Roentgen Film Caused by Extra-renal Tumors. Robert Bachrach and Karl Hitzenger. *Röntgenpraxis*, Nov. 1, 1930, II, 990.

Extra-renal tumors (liver, gall bladder, spleen) may change the shape of the kidney pelvis in a pyelogram by pressure in such a way that a differentiation of such a tumor from a renal neoplasm is not possible by means of a pyelogram. This fact is rarely mentioned in the literature. Eight case reports are given, with a reproduction of the deformities of the pelvis, in which four were caused by splenic tumors and four by the liver and gall bladder.

H. W. HEFKE, M.D.

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Multiple Myeloma as a Single Lesion. Charles F. Geschickter. *Ann. Surg.*, September, 1930, XCII, 425.

Geschickter and Copeland, in 1928, published a complete review of the literature on multiple myeloma, and added 13 case reports.

The six cardinal diagnostic features of the disease are: (1) Multiple involvement of the skeletal trunk by tumor formation in an adult over 35 years of age; (2) pathologic fracture of a rib; (3) the presence of Bence-Jones bodies in the urine; (4) lumbar backache, with signs of early paraplegia; (5) an otherwise inexplicable anemia; (6) a chronic nephritis, with nitrogen retention and low blood pressure.

The author presents in detail a case of a white male, 45 years of age, who showed evidence of only a single bone lesion, diagnosed as myeloma. He cites another case in a man 37 years of age, in which later films showed progression to other bones.

A brief discussion limited to differential diagnosis from giant-cell tumor, Ewing's tumor, and metastatic carcinoma is given, and the author concludes that a primary bone destructive lesion occurring centrally in a single bone, in the shaft of an adult, without expansion of the bone shell, should always excite suspicion of malignancy. Rarely the lesion may be a latent bone cyst; most frequently it is a metastatic carcinoma, but occasionally a multiple myeloma. The entire skeleton and lungs should be examined by the X-ray, for in this way the multiple myeloma or metastatic bone tumor, both hopeless diseases, may be disclosed and an unnecessary operation avoided. The urine must be examined for Bence-Jones bodies.

F. B. MANDEVILLE, M.D.

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Discussion of the Opaque Formations in the Abdomen, with Special Regard to Dermoid Cysts and Splenic Calcifications. Alessandro Vallebona. *La Radiologia Medica*, April, 1930, XVII, 365.

The author deals with the different shadows which may be observed in the abdomen, and discusses the difficulties offered by a diagnostic parallel. Special attention is given to the calcareous shadows which are apt to be overlooked by the radiologist, and to the differentiation of endocavitary deposits from calcic sediments in the tissues and from the shadows frequently observed in tumors and parasitic localizations. A comprehensive discus-

sion is given concerning various techniques the radiologist may resort to in locating them, and regarding the difficulties encountered in determining their intrinsic nature, and the organ in which the calcifications are located.

The author gives a complete description of the images of phlebolites, and illustrates some observations on calcification of the lymphatic gland and the peritoneum. He reports two cases of dermoid cysts of the ovary and two cases of calcification of the spleen.

L. MARINELLI.

**The Deposit of Active Bismuth in Malignant Tumors.** Herbert Kahn. *Strahlentherapie*, 1930, XXXVII, 751.

The author presents a preliminary report of his experiments dealing with the effect of a bismuth preparation on human carcinoma when injected intramuscularly or intravenously. It was possible to deposit as much as 8 mgs. per cent without ill effects. A series of animal experiments supported the contention that tumor tissue deposits more bismuth than normal tissue. A combination of bismuth injections with irradiation seems also to be promising. The author, therefore, invites his colleagues to the further study of this therapeutic procedure.

ERNST A. POHLE, M.D., Ph.D.

**Radiological Diagnosis and Radiation Therapy of Tumors of the Pituitary Body.** Quintino Vischia. *La Radiologia Medica*, April, 1930, XVII, 409.

The author reports two cases of tumor of the hypophysis treated by roentgen rays. A detailed description is given of the symptomatology, the radiological aspect, and the prognosis of this disease. He is generally in favor of radiation therapy in almost all the stages of the growth, because he considers it the most safe and the one which is the most likely to yield satisfactory results. The author observed in one of the patients thus treated a partial reconstruction of the sella turcica, and accounts for this phenomenon on the grounds that X-rays stimulate, in the irradiated region, a cerebral zone which controls

calcium metabolism. This would contradict the experimental findings of others who have noted a decrease in the calcium content of the blood after irradiation of the same zone.

The author concludes that it may be logical to assume the existence of a center, regulating calcium metabolism of the body.

J. MARINELLI.

**A Case of Sarcoma Botryiodes Corporis Uteri.** P. J. Kearns. *Canadian Med. Assn. Jour.*, September, 1930, XXIII, 418.

This is a case report of a very rare condition, the first to be recorded in the Clinic of the Women's Pavilion of the Royal Victoria Hospital, Montreal. A tumor, associated with the uterus, was found on operation to be a firm, grape-like, nodular mass the size of a four months' pregnancy, growing from the top of the uterus. Pathologic examination showed a partly edematous, partly myxomatous, partly lymphangiectatic spindle-cell sarcoma.

L. J. CARTER, M.D.

**Periosteal Lipoma: Report of Two Cases.** Edwin I. Bartlett. *Arch. Surg.*, December, 1930, XXI, 1015.

The author reports two soft tissue tumors which were sharply delimited, one lying in the soft tissues of the upper arm just above the elbow, and the other in the upper portion of the lower leg just below the knee. They were slightly lighter in density than the surrounding structures and had fan-like, radiating markings not bony in character. At operation these were found to be benign lipomas. They lay in immediate contact with the bone and were removed from it by sharp dissection. The periosteum below it was somewhat thickened, but the tumor came away intact.

HOWARD P. DOUB, M.D.

**Lipoma of the Mediastinum.** Wallace M. Yater and E. Stuart Lyddane. *Am. Jour. Med. Sci.*, July, 1930, CLXXX, 79.

The authors review the literature on 11 cases of previously reported lipomata of the mediastinum, and add one more case of their own,

that of a male, aged 44, who entered the hospital with symptoms of lobar pneumonia. On autopsy a lipoma was revealed, arising from the anterior mediastinum and weighing  $8\frac{1}{4}$  pounds. It displaced a large part of the right lung and extended over to the left side, partially covering the pericardium. Microscopic sections of the tumor showed that it was a pure lipoma. Lipomata may arise either from the mediastinum, the endothoracic fascia, or from the sub-peritoneal fat, forcing its way through the fibers of the diaphragm.

They conclude their article with a table including all the salient data of the 12 cases of lipoma of the mediastinum which have been reported.

ROE J. MAIER, M.D.

**Hypernephroma with Virilism in a Child of Three Years.** G. W. Harris and D. F. Plewes. *Canadian Med. Assn. Jour.*, August, 1930, XXIII, 244.

Tumors of the suprarenal cortex accompanied by virilism are rare, only 24 cases having been reported prior to this one.

This case, reported from the Brantford Clinic, was one of left hypernephroma accompanied by virilism. The evidences of the latter were abundant pubic hair, deepened voice, and the development of the clitoris to a length of one and one-half inches.

The hypernephroma was successfully removed. Ten months later the secondary sexual characteristics were remaining stationary, while there was no sign of recurrence of the tumor.

L. J. CARTER, M.D.

**Forcing the Demonstration of Canalization in Tumors of the Colon and Non-recognized Invagination of the Tumor.** A. W. Fischer. *Röntgenpraxis*, Dec. 15, 1930, II, 1114.

In order to make a differential diagnosis between a benign and malignant tumor of the colon, one should not be satisfied to demonstrate only a filling defect or the Stierlin symptom, but should try to visualize the canalization itself. The shape of the tumor will assist in making a more definite diagnosis.

It is often easy to show the canalization, but sometimes barium may be forced through only by inflation with air. The narrowing of the bowel lumen, so often explained by the tumor itself, is caused many times only by an invagination of a comparatively small tumor.

H. W. HEFKE, M.D.

**Three Primary Malignant Epithelial Tumors of the Ano-rectal Region Occurring in One Person.** D. M. Angevine. *Canadian Med. Assn. Jour.*, July, 1930, XXIII, 38.

This is the first case recorded, so far as the author can determine, in which three primary malignant tumors were so closely related anatomically. The case came into the clinic of Dr. C. P. Howard in the Montreal General Hospital.

At autopsy a large squamous-cell carcinoma almost encircled the rectum just above the anal canal. In addition, there were two other firm areas at the mucocutaneous junction. One of these was an adenocarcinoma, while the other was a malignant tumor of the peri-anal mucous glands. Numerous metastases were found in the liver, lungs, lymph nodes, vertebræ, and ribs, and all were of the squamous-cell type.

L. J. CARTER, M.D.

**Sarcoma of the Stomach: Report of Four Cases and Review of the Literature.** Rigney D'Aunoy and Adelaide Zoeller. *Am. Jour. Surg.*, September, 1930, IX, 444.

Sarcoma of the stomach comprises about 1 per cent of gastric malignancies. There are no pathognomonic features which give a pre-operative diagnosis. This is accomplished by a histological examination of an excised portion of the tumor or of one of its metastases. Roentgenologically, these tumors are impossible of differentiation from carcinoma.

They tend to occur at an earlier average age than does carcinoma. The prognosis of gastric carcinoma would appear to be slightly better than that for carcinoma, as the former does not appear to metastasize so readily or so early. Three hundred and thirty-five cases of sarcoma of the stomach, including the four

reported in this article, are recorded in medical literature for the year of 1929.

HOWARD P. DOWD, M.D.

### TUMORS (THERAPY)

**Multiple Myeloma: Report of Case.** Lloyd Bryan and Joseph Levitin. *California and Western Med.*, January, 1931, XXXIV, 15.

The authors report a case of multiple myeloma in which pain, the outstanding symptom in these conditions, was well controlled with X-ray therapy. This patient lived three and one-half years after the onset of the condition, which is nearly twice the average time. They discuss the clinical symptoms, laboratory findings, and differential diagnosis of multiple myeloma. The therapy used is only palliative, but in this case there was also a certain amount of new bone laid down, following the X-ray therapy. The article is illustrated with cuts of X-ray films and microscopic sections.

FRANCIS B. SHELDON, M.D.

**The Reaction to Irradiation as a Means of Differentiating Certain Varieties of Tumor.** Arthur U. Desjardins. *Brit. Jour. Radiol.*, January, 1930, III, 6.

Every variety of cell in the body and every organ or structure made up wholly or largely of one variety of cell, has a specific sensitiveness to the X-ray or radium ray. The lymphocytes in the spleen, lymph nodes, intestinal lymph follicles, bronchial nodes, thymus gland, and circulating blood are most sensitive, next to which come the spermatogonial cells of the testis, and basal epithelium of the ovarian follicles. In certain types of tumors included in the groups classified as lymphoblastomas and embryonal carcinomas of the testis, the tumor response to irradiation may prove a more accurate criterion to diagnosis than a microscopic study of the small biopsy specimen, since the irradiation test involves the whole tumor, while the biopsy study may include only the less important element of the tumor. Lymphosarcomatous tumors may

react even more rapidly than Hodgkin's disease or lymphatic leukemia, although in the average case the difference is scarcely recognizable.

The author calls attention to a group of tumors arising around the base of the tongue, tonsils, and nasopharynx which, microscopically, resemble epithelioma, but contain a considerable portion of lymphoid cells which are quite radiosensitive. These tumors have been called lympho-epitheliomas, a term which may be objectionable in the eyes of the pathologist, but serves to indicate their satisfactory response to therapeutic irradiation.

The only other tumor closely approaching the lymphoblastomas in irradiation response is the pure embryonal carcinoma of the testis. The mixed or teratoid tumors of the testis are much less responsive, and hence less effectively controlled.

The typical response of the benign giant-cell tumor to a moderate dose of rays is, at first, swelling, with redness and pain a few days after the exposure, but after about two weeks the swelling and redness disappear, and over a period of from six to twelve months the tumor area is usually replaced by dense bone.

Malignant tumors of bone are rarely very responsive to treatment, although usually Ewing's endothelial myeloma and the chondrosarcoma will show a prompt initial response to irradiation.

J. E. HABBE, M.D.

**Tumors of the Parotid Gland.** Edward B. Benedict and Joe V. Meigs. *Surg., Gynec. and Obst.*, November, 1930, LI, 626.

This is a report based upon the study of 225 cases of parotid gland tumor from the records of the Massachusetts General and the Collis P. Huntington Memorial Hospitals. The etiology, pathology, occurrence, signs and symptoms are discussed. Under the heading "treatment," the following statement is given: "The treatment in practically all cases should be operative. Radium or X-ray treatment in our experience has been only palliative, never curative. Moreover, without operation, no pathological report is obtained, so that, not



knowing with what type of tumor we are dealing, the treatment may be unsatisfactory, and no conclusions can be drawn from it. In a very large malignant tumor, in which there is no hope of cure, radium or X-ray may be used—chiefly valuable in recurrent malignant tumors. We are aware that some surgeons may have a higher regard for radiation treatment than we have, but certainly in this relatively large series of carefully followed cases, there is no evidence for attributing the permanent cure of a single parotid tumor to the use of X-ray or radium."

The authors summarize as follows:

1. Benign tumors are more common than malignant tumors in the ratio of about four to three.

2. Carcinoma is about twice as common as sarcoma.

3. Cysts, melanotic sarcomata, and adenomata are extremely rare.

4. Mixed tumors are essentially benign, but recur locally with great frequency. They rarely become malignant.

5. Malignant parotid tumors are very difficult to cure, and early radical operation is advised.

6. Patients with mixed tumors live indefinitely, while those with malignant disease rarely live over two years after operation.

7. Radium and X-ray are useful in the treatment of malignant parotid tumors, but only as palliative procedures. In the treatment of benign parotid tumors, radiation therapy is of benefit in some cases, but we believe excision is the treatment of choice.

8. Carcinoma, sarcoma, and malignant lymphoma may invade the parotid gland secondarily. Such cases usually end fatally, but one brilliant cure reported here justifies many extensive operations and emphasizes the importance of not giving up in our struggle against malignant disease.

D. S. CHILDS, M.D.

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Intrathoracic, Extra-pleural Granulation Tumors. Otto Dyes. *Fortschr. a. d. Geb. d. Röntgenstr.*, July, 1930, XLII, 45.

The paper contains a discussion of attempts at roentgenologic differentiation of pathology

of the thoracic cage, the pleura and peripheral pulmonary areas. For interpretation of marginal chest shadows, when tuberculosis, actinomycosis of thoracic cage, pleura or peripheral lung areas, pleural endothelioma, carcinoma, sarcoma—primary, as fibrochondromyxoneuro-sarcomata, or the more frequent metastatic—encapsulated pleural effusion, or lipoma have to be differentiated, considerable information may be obtained. However, especially in the cases of large tumor masses, often one cannot arrive at an etiological diagnosis.

The paper is illustrated by a few cases of tuberculous granulomata, forming dumb-bell shaped masses, partly in epicostal, partly in subcostal but extra-pleural location, and arising from small areas of caries in the ribs. It is stated that radiation treatment in doubtful cases may be used as a diagnostic aid, since tuberculous granulations are usually quite responsive to medium doses of roentgen therapy, while, for instance, actinomycosis requires much more intense irradiation.

HANS A. JARRE, M.D.

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A Few Cases of Sarcoma of the Uterus Treated by Irradiation. Cl. Regaud and A. Lacassagne. *Strahlentherapie*, 1930, XXXVII, 275.

The *rationale* of the treatment of uterine sarcoma is a much discussed problem. In this article the histories of six cases are fully related, accompanied by microphotograms of the different types of tumors. One case was treated in 1920 with radium alone. Since the methods used at that time are not comparable with the modern procedure, they cannot be used in the compilation of results. In only two cases could the complete irradiation (radium internally and X-rays externally) be carried out. In the three remaining women, the systemic reaction due to rapid tumor tissue destruction prevented further treatment. One completely treated patient is still free from symptoms three and one-half years later; in all the others, death occurred within six months following the beginning of the treatment. In operable cases, therefore, surgery

should be combined with pre-operative irradiation. Caution is indicated in inoperable tumors because of the possibility of aggravating the condition of the patient, due to infection resulting from the necrosis of the tumor.

ERNST A. POHLE, M.D., Ph.D.

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**The Management of Giant-cell Sarcoma of the Vertebrae: Report of a Case with Cure after Five Years.** John O. Bower, Jefferson H. Clark, and Leon Davis. *Arch. Surg.*, August, 1930, XXI, 313.

From the experience of the authors, they believe that giant-cell tumors of the vertebrae should not be considered benign, as compared with giant-cell tumors of the bone elsewhere. These tumors possess the tendency to metastasize rarely, to recur commonly, and to produce cachexia invariably. Operation is a very difficult procedure in the vertebrae, and in over one-half of the cases there were local recurrences.

The authors believe that the best treatment for this type of tumor is the insertion of radium into or near the growth, with as little trauma as possible. Giant cells are peculiarly susceptible to radium rays.

HOWARD P. DOUB, M.D.

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**Irradiation Therapy of Malignant Tumors in Sweden.** Gösta Forssell. *Wien. klin. Wchnschr.*, Sept. 18, 1930, XLIII, 1161, and Sept. 25, 1930, XLIII, 1194.

The conditions at the Radiumhemmet gave an excellent opportunity to draw conclusions about the irradiation therapy of malignant tumors. Not only could inoperable patients be treated with X-rays and radium, but a great many borderline cases and operable cases, as well, were treated by means of radiotherapy only. The follow-up of the patients could be so perfected that the statistics, since 1910, are almost complete. Irradiation therapy alone led to a five-year cure in skin carcinomas in 69 per cent of all cases, and in 78 per cent in operable cases. Surgical end-results, taken from a large group of Swedish statistics, show a five-year cure in 65 per cent in the

operable group. In carcinoma of the lip, radiotherapy reached 68 per cent of five-year cures, and surgery 62 per cent. Included in the irradiated group, however, were 20 per cent of inoperable cases. Carcinomas of the oral cavity, of which 75 per cent were inoperable, showed 18 per cent of five-year cures when treated by radium and X-rays. Surgery was responsible for 41 per cent of five-year cures in carcinoma of the tongue with metastases, while irradiation brought the percentage up to 60. Carcinomas of the cervix uteri, of which 75 per cent were inoperable or borderline cases, showed a five-year cure in 26.6 per cent with irradiation, 18 per cent with surgery. If one considers operable and borderline cases only, the percentage is 40.4 by irradiation and 35.6 by surgery. Carcinoma of the corpus uteri showed about the same results (43 per cent) by either means of treatment. Twenty-four per cent of all primary sarcomas could be cured for five years, the greatest number of all cases being inoperable; 18 per cent of recurrences after operation could still be cured.

These results permit of the conclusion that irradiation therapy in these tumors stands very well compared with surgery alone. For carcinoma of the skin, lip, and uterus, irradiation therapy should be considered the method of choice, sometimes in combination with surgery. Good results by X-ray and radium can be achieved in other tumors also, as carcinoma of the thyroid, vulva, ovaries, and breast, but only inoperable cases have been treated and statistics are not available as yet. A combination of surgery or electrocoagulation with irradiation has been used more and more during the last ten years. Such a combination has led to 77 per cent of three-year cures in carcinoma of the lip, 75 per cent of three-year cures in carcinoma of the tongue, and 80 per cent in oral carcinoma without metastases. For carcinoma of the breast, pre- and post-operative irradiation is the method of choice. Combined surgery and irradiation prolongs the life of such patients longer than surgery alone, and local recurrences in the irradiated fields are comparatively infrequent. Radiotherapy in combination with surgery ought to be the

method of choice in carcinomas of the mouth, the maxilla, the breast, the pharynx, the thyroid, the ovaries, and the external female genitalia. In borderline cases of carcinomas of the pharynx and thyroid, irradiation alone should be employed. In 40 per cent of all cases of carcinoma, irradiation therapy either with or without surgery is indicated; the other 60 per cent, however, belong to the surgeon alone, including all carcinomas of the digestive tract. Of 4,470 carcinoma patients from 1921 to 1927, 38 per cent were symptom-free for shorter or longer periods; 24 per cent of all sarcomas could be made symptom-free. The palliation produced by radiant energy should not be minimized, and the above results give some indication of such action.

Only well equipped centers are able to develop irradiation therapy to such an extent that it may compete with surgery. Co-operation between the surgeon and the radiologist is essential to good results. Radium and X-rays alone cannot cure a carcinoma—able and well trained physicians must administer them.

H. W. HEFKE, M.D.

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Three Cases of Neuroma: Cirroid Neuroma of Face; Neurofibroma of Stomach; Posterior Tibial Neurofibroma. James T. Case. *Am. Jour. Surg.*, March, 1930, VIII, 648.

Three cases of nerve tumors of the neurofibroma type are described.

The first case was an extensive cirroid neurofibroma of the head and face, with roentgen evidence of bone changes in the frontal and parietal area, and distortion of the facial bones. This was treated by combined surgical and roentgen therapy and the patient has remained well for fifteen years. Inasmuch as this had previously recurred following surgical treatment alone, it is suggested that radiation therapy should be applied to these cases either alone, or as a supplement to surgical intervention.

The second case was a large neurofibroma of the posterior wall of the stomach near the pylorus.

The third case was a neurofibroma of the

posterior tibial nerve. This can be seen on a plain roentgenogram as a soft-tissue shadow.

H. P. DOUB, M.D.

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### ULTRA-VIOLET LIGHT

The Use of Ultra-violet Light (Osram-Vitalux-Lamp) in Diseases of the Respiratory System. A. Moeller. *Med. Klin.*, June 13, 1930, XXVI, 887.

During his studies of the influence of ultra-violet radiation on diseases of the respiratory system the author found that beginning colds frequently may be checked, especially with radiation through the open mouth. Light therapy in pulmonary tuberculosis should be handled very carefully. All cases of active tuberculosis, especially of the exudative type, should be excluded from any light therapy. An elevated temperature and hemoptysis are contra-indications also. In chronic cirrhotic types and in the productive type one can use light therapy with success. The treatment should be done very carefully and the dose should be varied according to individual indication. One must realize that the action of the ultra-violet rays on the lung tissue must be an indirect one. Treatment of bronchial and cardiac asthma has not been successful. In tuberculosis of the hilum glands one may notice a distinct decrease in size only after irradiation for several months.

H. W. HEFKE, M.D.

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The Dosage of Ultra-violet Radiation in Infants with Tetany. Harry Bakwin and Ruth Morris Bakwin. *Jour. Am. Med. Assn.*, Aug. 9, 1930, XCV, 396.

There is a widespread impression that, if excessive skin irritation is avoided, the greater the amount of ultra-violet radiation given, the better. Numerous observations indicate that the effect is not proportional to the dosage and that an effect produced by a smaller dose may be reversed when a larger dose is given. When cholesterol or ergosterol is irradiated, the antirachitic potency rises for a time and then falls as the irradiation is continued.

The effect of measured amounts of ultra-violet radiant energy on the serum calcium of

twenty-eight infants with tetany was studied. The intensity of radiant energy was measured by the oxalic acid-uranyl sulphate method of Anderson and Robinson.

In the use of ultra-violet radiation for infants with tetany, there is an optimal range of dosage above and below which the rate of rise in the serum calcium is slowed. A daily dosage of two minutes front and two minutes back at 50 cm. is optimal unless the burner is badly deteriorated.

When large enough doses of ultra-violet radiation are used, the average daily rate of rise in the serum calcium of white and of Negro infants with tetany is about the same, but the minimal dosage necessary for cure is greater in Negro than in white infants.

CHARLES G. SUTHERLAND, M.D.

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On the Ultra-violet of the Sun. Ch. Fabry and H. Buisson. *Strahlentherapie*, 1930, XXXVI, 410.

The Intensities of the Short Ultra-violet Rays in the Sun Spectrum. F. W. Paul Götz. *Strahlentherapie*, 1930, XXXVI, 429.

The paper by Fabry and Buisson presents data on the amount of radiation emitted by the sun as compared with the amount reaching the earth. It concludes with a graphic presentation of the composition of the ultra-violet in the sun spectrum after passing through the atmosphere.

Götz offers the results of measurements carried out in Arosa on a clear summer day, and compares the erythema effect of the ultra-violet in the sun before and after filtration through the atmosphere.

ERNST A. POHLE, M.D., Ph.D.

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Osteitis Deformans: Its Treatment by Ultra-violet Rays. Clement Nicory. *Brit. Med. Jour.*, March 15, 1930, No. 3610, p. 492.

Case histories are given of four patients with osteitis deformans treated by irradiation with ultra-violet light, using a mercury vapor lamp. Over a period of three years these cases have shown a complete disappearance of symptoms, with a marked return of the

bones to normality. Comparative X-ray films are reproduced.

The author publishes these cases with a view to getting a greater number of patients treated by this method, and having his findings confirmed or otherwise.

WALLACE D. MACKENZIE, M.D.

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Ultra-violet Light in the Treatment of the Dull and Backward Child. Frank Sugden. *British Med. Jour.*, Nov. 29, 1930, No. 3647, p. 905.

The author has had considerable experience in the institutional treatment of dull and backward children, and has been impressed by the improvement in the standard of mentality of many of the cases under treatment by actinotherapy. He suggests that as there is no definite line of demarcation between the dull and backward and the mentally deficient type, it is reasonable to assume that patients may be selected and their standard of mentality be considerably raised by actinotherapy. The same standard of improvement cannot be expected to obtain in every case, but, with the exception of those children who turn out to be of definite mental deficiency, it is very exceptional to find one who will not show signs of both physical and mental development.

WALLACE MACKENZIE, M.D.

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On a Case of Similar Effect of Ultra-violet and of Roentgen Rays. K. Brummer. *Strahlentherapie*, 1930, XXXVI, 716.

In white rats weighing from 40 to 60 grams, rickets was produced by omitting vitamins from their food. After three weeks, roentgenograms were taken as a control, and a part of the animals was then treated with ergosterol which had been activated by roentgen rays of long wave length. The ergosterol had been irradiated in powder form by roentgen rays produced at 7 K.V., 10 ma., 3 cm. F.D., for 60 seconds and also for 60 minutes. Each rat received 0.0006 mgs. ergosterol per day. The control rats were kept on the same amount of unirradiated ergosterol. The rats which had received the irradiated ergosterol for three weeks did not show any signs of

rickets and had gained from 20 to 30 grams. The control animals showed severe symptoms of rickets and two had died before the end of three weeks.

The author concludes from these experiments that roentgen rays of long wave length can also activate ergosterol.

ERNST A. POHLE, M.D., Ph.D.

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**Symposium on Ultra-violet Therapy.** Med. Jour. and Record, Dec. 17, 1930, CXXXII, 591.

This is a series of articles on various aspects of ultra-violet therapy, as follows: "Different Methods of Applying Ultra-violet Radiation," by W. Kerr Russell, of London, England; "Biological Studies of Sunlight Filters," by Walter H. Eddy, of New York; "The Status of Window Materials for Transmitting Ultra-violet Radiation," by W. W. Coblenz, of Washington, D. C.; "The Measurement of Therapeutic Ultra-violet," by Roger S. Estey, of New York; "The Tungsten Arc as a Source of Ultra-violet Radiation," by W. J. Turrell, of Oxford, England; "The Decrease in Ultra-violet and Total Radiation with Usage of Quartz Mercury Arc Lamps," by William T. Anderson, Jr., of Newark, N. J.; "Sunshine for Therapeutic Use," by M. J. Dorcas, of Cleveland, Ohio.

The series of papers constitutes a good review of the technical and physical phases of ultra-violet radiation, and are recorded here, without abstracting, for the information of those who may be looking for such references.

W. W. WATKINS, M.D.

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**The Effect of Ultra-violet Radiation on Tissue Cultures.** Edmund Mayer. *Strahlentherapie*, 1930, XXXIX, 148.

In this paper, the results of extensive experiments concerning the effect of visible light or ultra-violet light alone, and of a combination of both—of an ultra-violet line or a continuous spectrum—on fibroblast cultures are reported. A quartz mercury vapor lamp and a Vitalux lamp served as sources of radiation. It appears that visible light alone inhibits the growth and that ultra-violet light alone inhib-

its it more or less. For the effectiveness of ultra-violet light, the presence of visible light is quantitatively without any influence. The continuous ultra-violet spectrum produces the same effect as an ultra-violet line spectrum. The various degrees of inhibition of growth can be brought about by varying the exposure time and by any combination of ultra-violet rays. It seems, therefore, that the inhibition of growth in tissue cultures may be used as a biologic measurement method for ultra-violet radiation. Numerous graphs and a few photomicrograms illustrate the article.

ERNST A. POHLE, M.D., Ph.D.

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**The Effect of the Visible Light, the Infra-red, and Ultra-violet Rays on the Eye.** Wolfgang Hoffmann. *Strahlentherapie*, 1930, XXXIX, 93.

This is a brief review of our present knowledge concerning the effect of light rays on the various parts of the eye. It is stated that the so-called "glass-blower's cataract" is in all probability caused by infra-red rays, although no definite experimental proof has been furnished for this assumption.

ERNST A. POHLE, M.D., Ph.D.

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**Erythema Tests with the Vitalux Lamp.** Stephan Epstein. *Strahlentherapie*, 1930, XXXVIII, 372.

In view of the discrepancies in literature concerning the erythema effect of the Vitalux lamp, the author exposed a number of patients to this light under various conditions. He found that a true ultra-violet erythema could be produced in four out of seven cases following an exposure of two hours, at 90 to 100 cm. distance, over an area of 3 cm.  $\times$  4 cm.

ERNST A. POHLE, M.D., Ph.D.

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**Cutaneous Papillomata in the Rat Following Exposure to Ultra-violet Light.** G. M. Findlay. *Lancet*, June 7, 1930, CCXVIII, 1229.

Although much attention has been paid to chronic irritation by many substances in the production of cancer, little attention has

been paid to the possibility of carcinogenic action by ultra-violet rays, although there is abundant clinical evidence to suggest that prolonged exposure to sunlight rich in ultra-violet is a cause of skin cancer in man. In Australia, where there is a Northern European population exposed to prolonged and intense sunlight, rodent ulcer and epithelioma of the skin are far commoner than in Great Britain, and, in addition, white cattle in Australia are especially liable to develop epitheliomata, so much so that in Queensland farmers have now abandoned the breeding of white cattle, owing to their liability to develop cancer of the skin. This parallelism of extreme liability to skin cancer in poorly pigmented persons and animals is very striking, and strongly suggests that chronic dermatitis, due to excessive exposure to sunlight rich in ultra-violet, plays a not unimportant part in the etiology of skin cancer both in man and in cattle.

In a previous communication (1928) the author brought forward evidence to show that exposure to the mercury vapor lamp is capable of exciting carcinomatous changes in the skin of a mouse, if these are continued over a period of at least eight months. He now reports similar experiments on albino rats. Six of these animals were used, about six months old, and, after epilations with sodium sulphide, were exposed to the light of a mercury vapor lamp three times a week. Three of these rats were alive eighteen months later and apparently in normal health (nothing is said as to the cause of death of the other three). One month later the author referred to one of the two surviving rats, so that a fourth must have died in that period. At twenty months, a small papilloma was noticed on the dorsal surface of the right ear of this animal, which had, at nineteen months, developed a white opacity in the cornea of the right eye. This papilloma of the ear grew rapidly into a large, horny excrescence. A month later two small ones appeared on the dorsal surface of the left ear. At this period the rat died of bronchopneumonia. Microscopically, the tumor of the right ear had all the appear-

ance of a rapidly growing papilloma, with cell-nest formation and much keratinization; cartilage of the ear was intact. There was no infiltration or metastases, but the author believes that such a rapid growth suggests that infiltration would have occurred had the animal lived longer, and it should also be noted that the growth continued in the absence of further exposures to the lamp. Microscopic study of the eye may have been a sarcomatous condition of the conjunctiva, but it is believed that it was more probably a chronic inflammatory lesion.

H. J. ULLMANN, M.D.

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Further Studies on the Biological Action of Radiations of Different Wave Lengths. Ettore Conte. *La Radiologia Medica*, June, 1930, XVII, 689.

The results of these experimental researches seem to contradict the findings of Ludwig and von Ries, who believe in an antagonistic action between ultra-violet and infra-red rays. They may be summarized as follows:

(a) The biological action of ultra-violet rays on experimental rickets of white mice cannot be prevented or retarded by infra-red radiation.

(b) This fact is verified when the radiating energy is administered for either therapeutic or preventive purposes.

(c) Infra-red rays alone may accelerate, within certain limits, the manifestations of rickets in mice fed with Steenbock's diet.

L. MARINELLI.

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The Principles of a new Ultra-violet Dosimeter. Edith Weyde. *Strahlentherapie*, 1930, XXXVIII, 378.

An instrument is described for the measuring of the erythema producing part of the ultra-violet spectrum, making use of a light-sensitive solution. When exposed to ultra-violet light, the solution changes to a blue color and discolors again in the dark. It can, therefore, be used for several hundreds of tests. The degree of bluing is determined by a colorimeter whose scale is calibrated in terms of skin erythema. Investigations proved

that the so-called "I  $\times$  T law" (Intensity  $\times$  Time) does not hold in this case. It is necessary to add a correction factor which was found to be 0.7 in twelve examined persons. The relation has to be changed, therefore, to  $I \times T^{0.7}$ . The error of measurement amounts to plus or minus 20 per cent.

ERNST A. POHLE, M.D., Ph.D.

**Sources of Radiation and Their Physical Characteristics.** W. W. Coblentz. *Jour. Am. Med. Assn.*, August 9, 1930, XCV, 411.

This supplements a previous paper (June 1, 1929), with data on sources of ultra-violet and infra-red radiation. There seems to be sufficient biologic evidence to show that the effect of ultra-violet radiation is photochemical, and that there is a minimum or threshold value below which this action is ineffective, especially as regards the physiologic action obtained in an exposure of reasonable length.

The tungsten filament lamp, even when enclosed in a bulb that transmits the ultra-violet rays of wave lengths from 280 to 310 millimicrons, emits but little ultra-violet rays of these wave lengths.

The ultra-violet spectrum of the mercury arc consists of a series of intense emission lines irregularly distributed throughout the ultra-violet and visible spectrum.

The incandescent tungsten filament produces a continuous emission spectrum having a high intensity throughout the visible into the infra-red.

A recent production is a combination of a mercury arc between highly incandescent electrodes of tungsten. A tungsten filament operates in parallel with the mercury arc, but it is at a considerably lower temperature than the incandescent tungsten electrodes. The surrounding globe, of special glass, absorbs the rays of wave lengths less than 280 millimicrons not present in sunlight. The mercury arc supplements the ultra-violet radiation at from 280 to 365 millimicrons, which is only feebly emitted by the incandescent tungsten electrodes.

The result of this combination of incandescent solid and arc-vapor radiation is an unusual emission spectrum, consisting of a series

of strong ultra-violet emission lines of mercury vapor superimposed on a continuous spectrum radiation from the incandescent solid, which increases rapidly in intensity and extends throughout the visible and into the deep infra-red.

No data were obtained in the effect of aging of the lamp.

By means of a sensitive sodium in quartz bulb photo-electric cell it was found impossible to measure the ultra-violet rays from a radiant gas heater after provision was made that the burner be over-rated in order that measurements might be procured in normal operation, and also when an excess amount of gas was used. An attempt was made to measure the ultra-violet radiation emitted by the gas flame. Instead of attempting to use the radiant gas heater as an ultra-violet radiator, it should be obvious that such a radiant gas heater is an excellent source of intense infra-red radiation.

Various radiant heaters used for therapeutic purposes do not differ in principle from those used for heating dwellings.

CHARLES G. SUTHERLAND, M.D.

**The Biologic Test of the Ultra-violet Radiation Emitted by a Vitalux Lamp.** Lothar Böhmer. *Strahlentherapie*, 1930, XXXVI, 805.

The Vitalux lamp is constructed like an ordinary incandescent lamp but its bulb is made of ultra-violet transmitting glass. Since some investigators have questioned the ultra-violet emission of this lamp in the region around 3,000 Å., the author exposed fields on the chest and abdomen of patients, at 80 cm. distance, for 90 minutes. In each case, half of the area was covered by glass which did not transmit below 3,300 Å. After 20 hours, a definite erythema appeared on the uncovered area. A photograph of the reaction and also a spectrogram of the Vitalux lamp, unfiltered and filtered through the glass, are appended. The conclusion arrived at is that there is sufficient radiant energy below 3,300 Å. in the emission of the Vitalux lamp to produce an erythema.

ERNST A. POHLE, M.D., Ph.D.

The Irradiation of Body Cavities by Ultra-violet Light Generated in Them. Stephan Westmann. *Med. Klinik*, Aug. 1, 1930, XXVI, 1146.

The author describes some instruments designed to bring direct ultra-violet radiation into body cavities. For treatment of laryngeal lesions an endoscope has been devised, with a quartz window on its tip and the mechanism which produces the ultra-violet rays in the endoscope itself. A cystoscope has been constructed similarly. Electrical accidents are avoided by insulation. Spectral analysis shows emission of ultra-violet rays in sufficient amounts to cause a definite reaction. Exposure of limited areas in body cavities is possible with these devices, and may lead to therapeutic results.

H. W. HERKE, M.D.

On the Time Factor of the Reaction of Albumin to Radiation. Wolfgang Gentner and Kurt Schwerin. *Strahlentherapie*, 1930, XXXVII, 788.

The authors continue their experiments concerning the effect of radiation on albumins. In this paper, they report the results of the effect of different intensities of ultra-violet rays on albumin solutions. The latter were exposed in a quartz tube which had been placed in front of the chamber of a dosimeter. The authors found that the time factor is almost equal to one and that only with very high intensities of the radiation employed is there a definite difference in the reaction.

ERNST A. POHLE, M D., Ph.D.

## WOUNDS (THERAPY)

The Healing of Operative Wounds in Irradiated Tissues. Vittorio Podestà. *Rivista di Radiologia e Fisica Medica*, August, 1930, II, 446.

The author reports some experiments on rabbits on the healing of wounds, and concludes that large doses of radium delay the

process of cicatrization, and if the doses are very large there is no healing whatever. These doses produce a necrosis of the deeper tissues in direct contact with the radium which does not permit healing to take place until the necrotic tissue has sloughed, and the superficial tissues at the same time show little tendency to close in. As a corollary, the author is of the opinion that in radiosurgery it is best to treat the wounds as lacerated-contused wounds, with great traumatism to the tissues, to wait for sloughing and localization of the process, and then to make a wide excision, followed by suture, through healthy tissue.

The article is supplemented by many photomicrographs and a bibliography.

E. T. LEDDY, M.D.

The Rate of Healing of Electrosurgical Wounds as Expressed by Tensile Strength. John D. Ellis. *Jour. Am. Med. Assn.*, Jan. 3, 1931, XCVI, 16.

For the purpose of description of the histologic effects of high frequency cutting currents on tissues, the relative and roughly descriptive terms of cutting, desiccation, and coagulation can be accepted. The use of cutting currents, with just enough desiccation to control capillary hemorrhage without resulting in coagulation and slough, has made justifiable many surgical operations in easily bleeding fields that would formerly have been considered foolhardy. Examples of this are the revolutionizing of brain surgery, partial hepatectomy, and splenectomy for laceration; widespread excisions of facial cancers without subsequent slough, and operations on the jaundiced patient, who is prone to bleed freely from the incisions. The enthusiasm for the new surgical currents has led to some quite optimistic reports regarding uniformly primary healing and rapid cicatrization of electrosurgical incisions.

A study of the tensile strength per centimeter of length, at various time intervals, of healing incisions of skin, muscle, and stomach were performed in dogs. Control scalpel wounds were made. Only 60 per cent of the



electrically produced skin wounds showed primary union in comparison with 97.5 per cent of primary union in the control scalpel wounds, which indicates the futility of expecting primary skin healing in a fair percentage of electrical wounds. When union did occur, the wound was somewhat weaker than in corresponding scalpel wounds, and in the case of heavy dehydration did not attain a strength equal to the scalpel wound in twenty-one days. The stomach and muscle incisions electrically produced show the same percentage of primary union as the scalpel wounds. The electrically produced stomach wounds are notably weaker at about the mid-point of healing. The electrically produced muscle wounds are of almost equal strength with the scalpel wounds through the entire healing period.

While these observations do not argue against the employment of the electrosurgical knife for making surgical incisions when clear-cut indications for its use present themselves,

this method cannot be considered as a practical substitute for the scalpel for routine use.

CHARLES G. SUTHERLAND, M.D.

---

#### Studies on the Prophylactic Effect of Irradiation on Inflammations.

On the Influence of Roentgen Rays on the Healing of Wounds. Shuichi Fukase. *Strahlentherapie*, 1930, XXXVI, 95 and 102.

The author studied the effect of roentgen rays upon the healing of skin wounds in rabbits. Two types of radiation were used, 170 K.V., filtered through 3.0 mm. Al or through 0.5 mm. Zn. The dose in both cases amounted to 400 r. It appeared that the heavily filtered irradiation was more effective. The wounds healed much quicker than the untreated parts; there is a true inhibitory action of roentgen rays on the inflammatory reaction in tissue.

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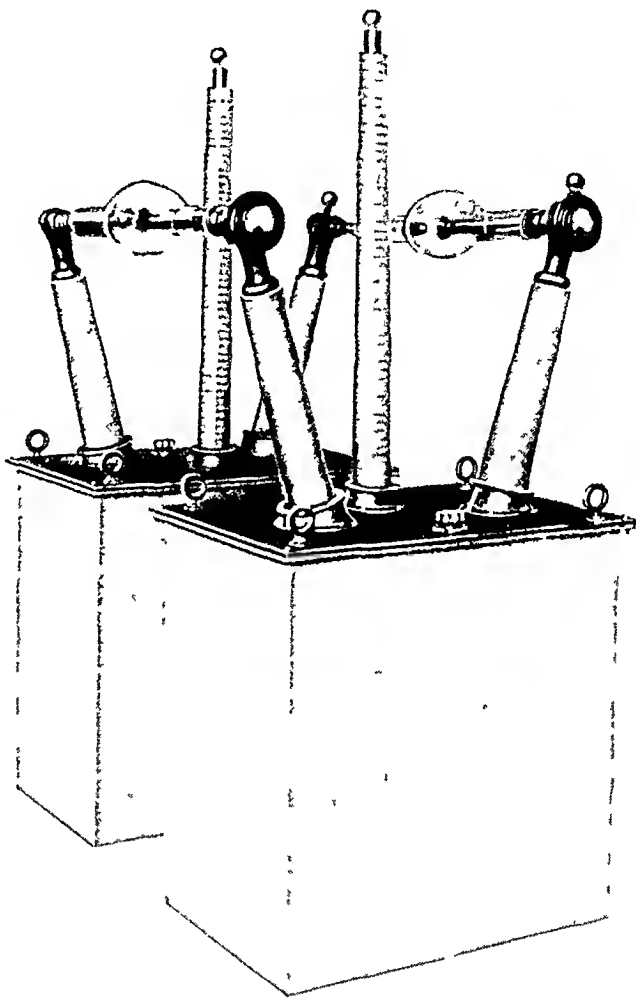
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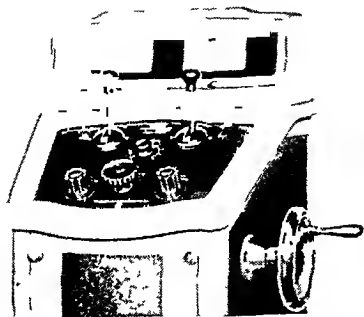
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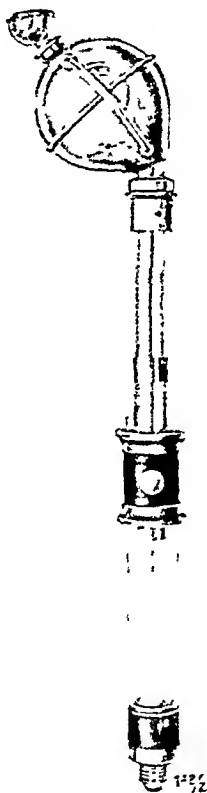
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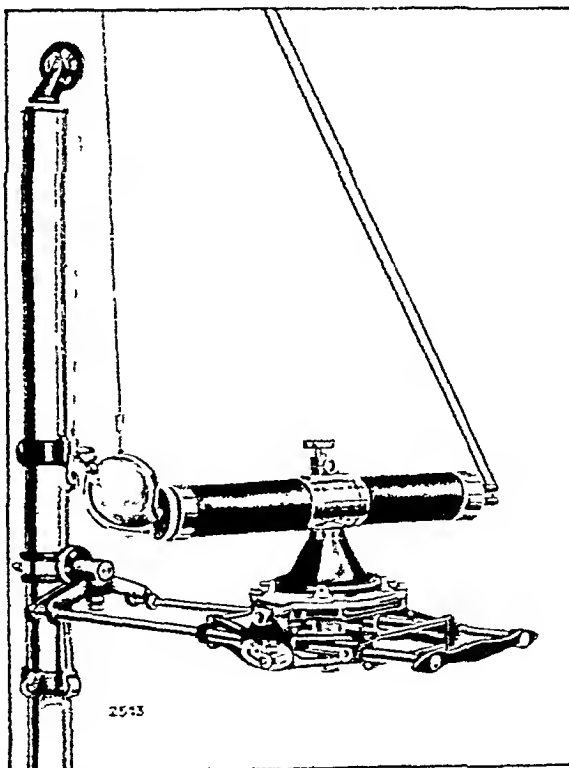
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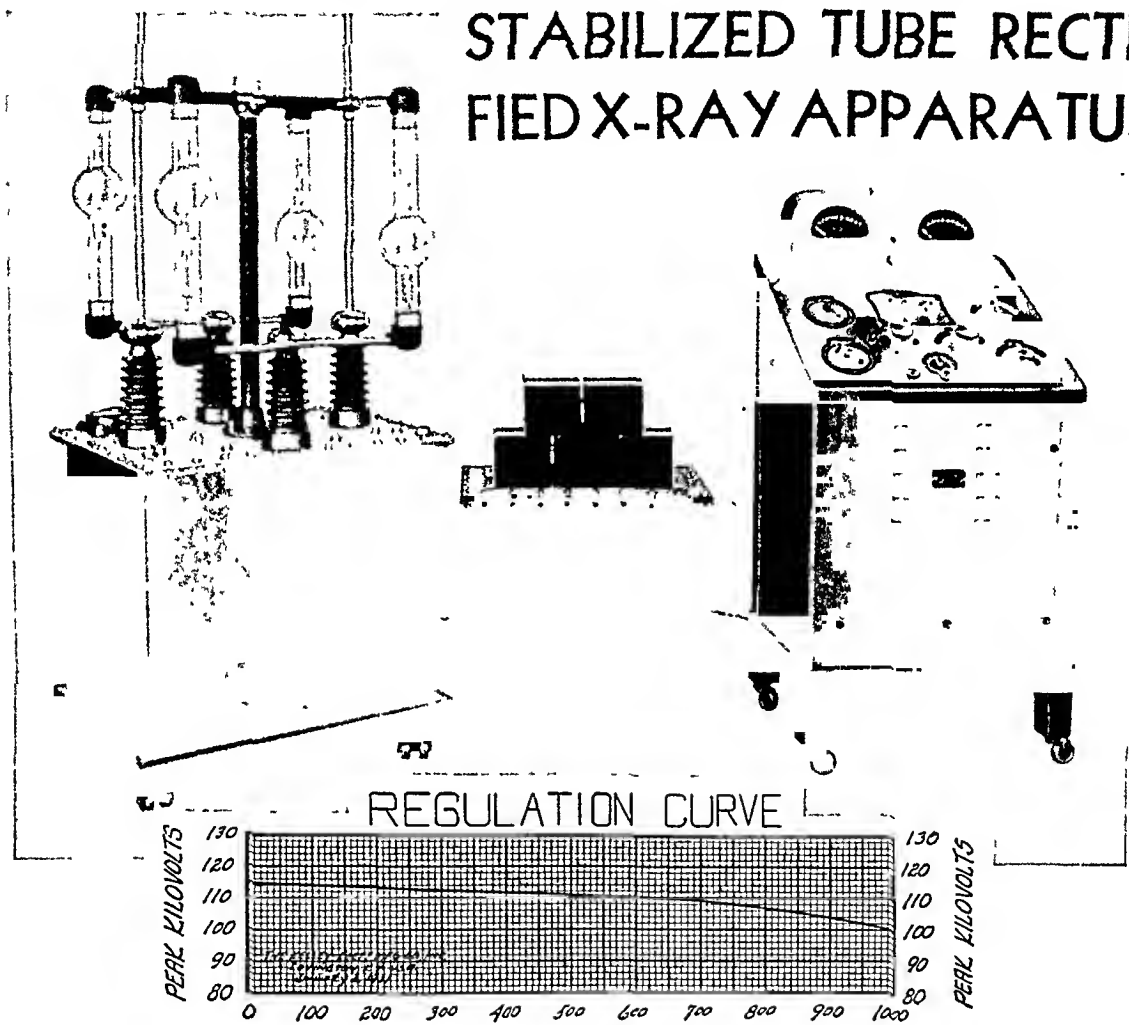


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Post convention tour to British Isles or Russia optional (details on request). Societies tour officially ends when convention ends, but every one furnished with ticket back to United States good on any French Line cabin steamer. No attempt is made here to give list of things we do in the above cities and countries except to say we cover everything of interest in the best manner. The ladies will be entertained while the doctors are at clinics.

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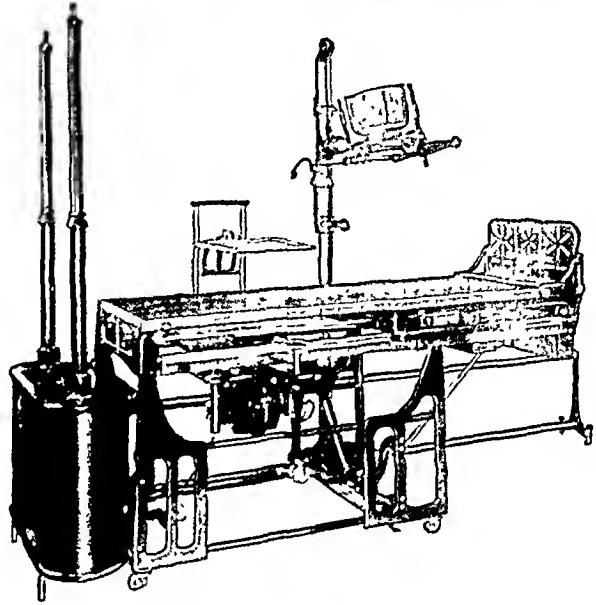
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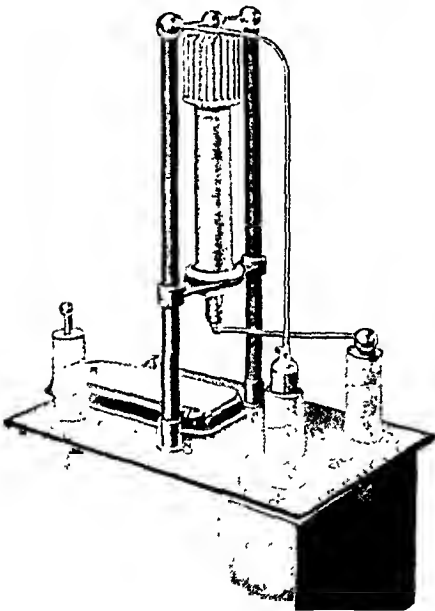
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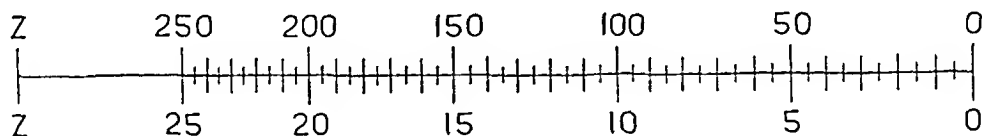
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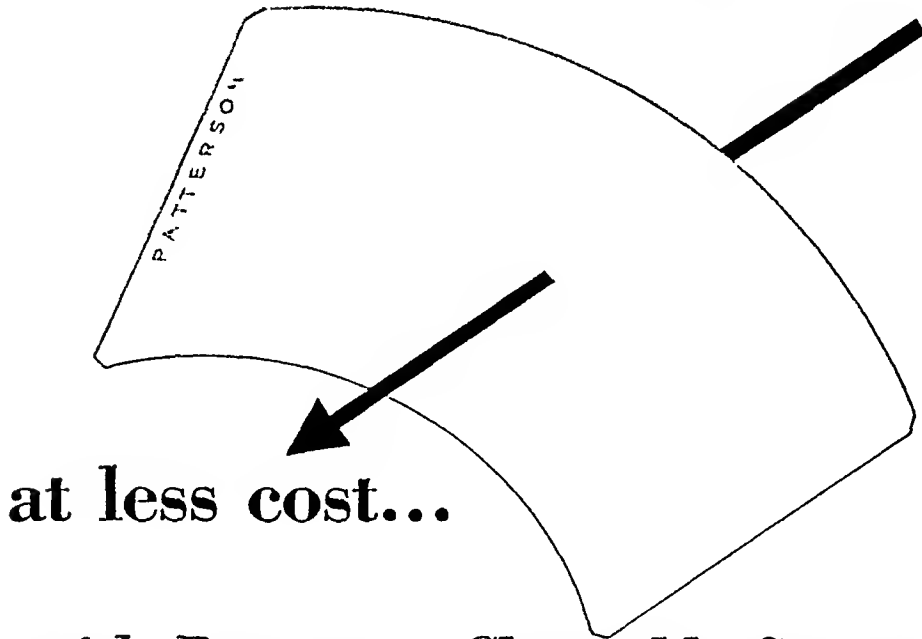
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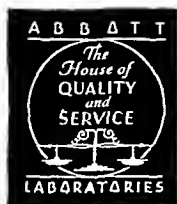
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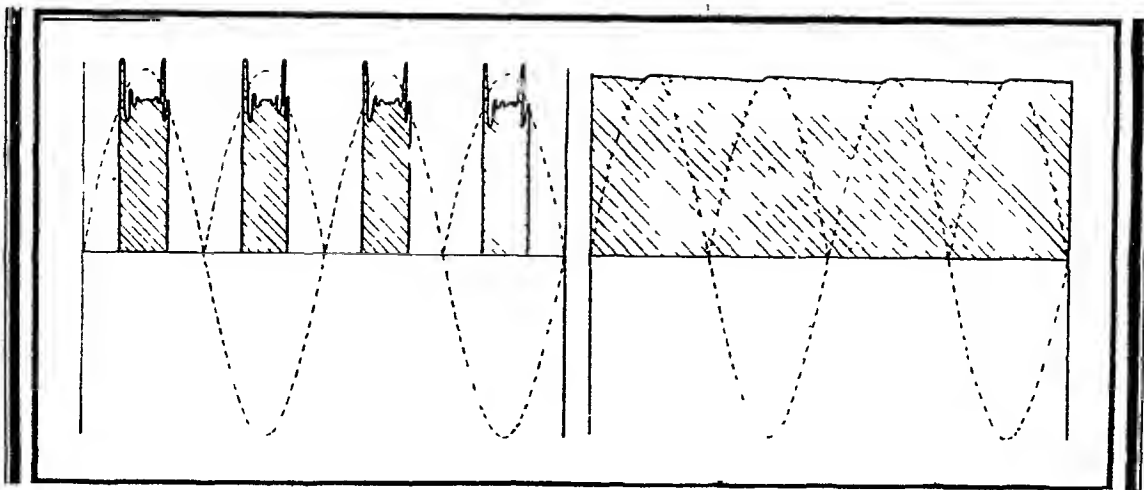
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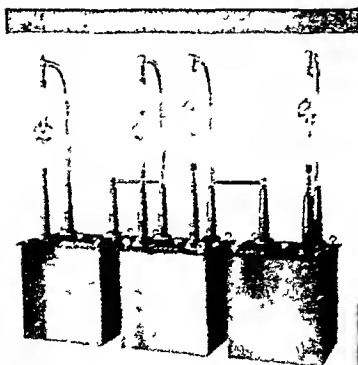
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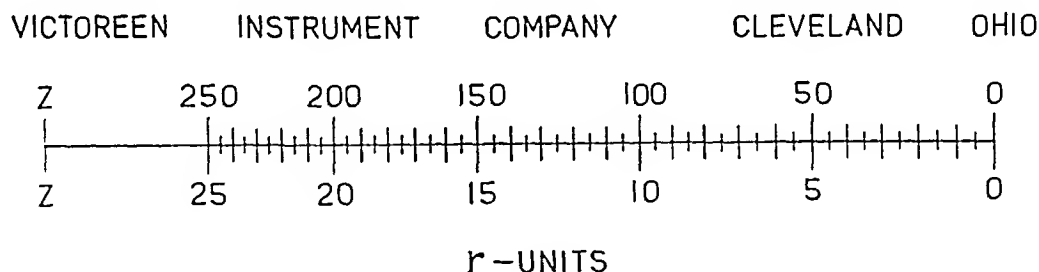
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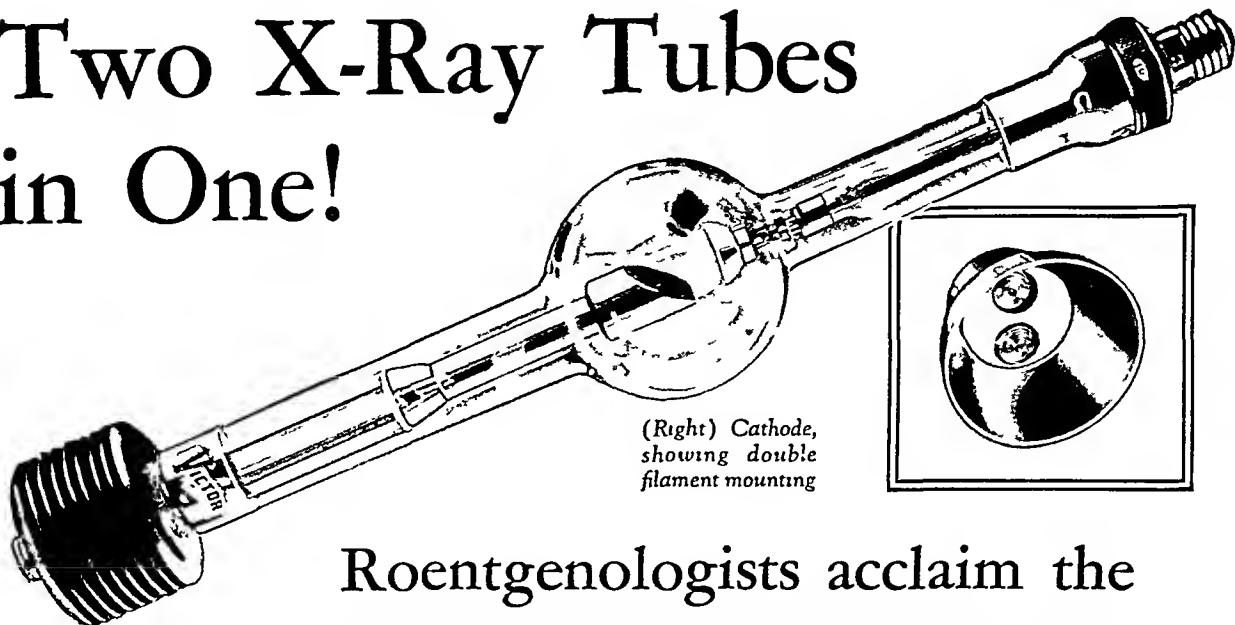
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
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## SKIN MALIGNANCY<sup>1</sup>

COMMENTS ON THERAPY

By ROLLIN H. STEVENS, M.D., DETROIT, MICHIGAN

THE treatment of malignancy is now a most important specialty embracing several other specialties in general science and in medicine. The treatment of skin malignancies should also presuppose a special knowledge of dermatology.

Up to 1895, surgery, by means of caustics, cautery, or the scalpel, held the undisputed field of therapy in the combat against cancer, which was generally believed to be of local origin. Then radiation entered into the field, and, with it, came an ever increasing accumulation of facts concerning the natural history of neoplasms, and the effects of radiation of various wave lengths, from the hertzian to the gamma field, upon the elements of normal and diseased living tissue.

The result of this thirty-five-year development has been to limit the field of operative surgery in the therapy of malignancies, and especially of skin malignancies, to a very large extent.

Expert application of the new knowledge requires long and special study and training along many different lines, including the physics, chemistry, and biology of rays of all wave lengths, and a good foundation in general medicine, especially in pathology

and roentgen diagnosis. The physician who has not had special training and experience in these branches of science should not undertake to treat malignancies of the skin or other organs. Many, many times ill-advised surgery or insufficient radiation has spelled the death-sentence of credulous patients who could have been saved by expert treatment begun early.

The practice in these days of operating an X-ray machine solely or principally upon knowledge gleaned from the salesman, and of applying radon or radium without proper training in its use, cannot be too strongly condemned and should not be permitted. The public and the profession must be educated to the importance of giving proper recognition to the trained radiologist and specialist in neoplastic diseases.

The therapy of cancer, as of other diseases, depends largely upon its etiology and pathology.

Is cancer a constitutional or a local disease in its beginning?

For many years the answer has been that it is local; hence, removal by surgery was the cure.

But there appears to be more and more of a tendency to regard it at least as an inherited susceptibility and to accept wholly or in part the conclusions of Slye from her

<sup>1</sup>Read before the Radiological Society of North America, at Los Angeles, December, 1930.

classical work on mice. Other possible constitutional factors are being more and more seriously considered.

A degree of immunity of different organs against, or of susceptibility to, certain types or grades of cancer seems to exist. Why is squamous-cell carcinoma the type usually found in the cervix uteri and not in the fundus uteri? And, on the other hand, why is adenocarcinoma almost invariably limited to the fundus? Why is basal-cell carcinoma found in the skin of the face more frequently than the squamous-cell type, while on the back of the hand we find only the squamous cell? Why is a sweat gland carcinoma rarely found, and, when it is, why does it usually involve the face? Why do metastases vary so much in their usual distribution? An adenocarcinoma of the breast, for instance, will frequently metastasize to the lungs, the liver, the vertebræ, the humeri, or the femora, but very rarely to the spleen, or to the bones below the elbows or knees. In bone involvement, in such cases, the metastases must surely be blood-borne, and, if so, why is there apparently selective involvement? The cancer cells or virus must be distributed everywhere. Can we explain distribution of metastases entirely upon an anatomical or a physiological basis? If so, how explain the early and almost certain metastasis from a Grade 3 or 4 squamous-cell carcinoma of the cervix and a very delayed and uncertain metastasis from a Grade 1 or 2 squamous carcinoma of the same region? Why does not a basal-cell carcinoma of the skin metastasize and why does a squamous cell always metastasize? Why does a melanoma metastasize so much more rapidly and diffusely than a squamous cell of the skin? Evidently grade of differentiation and type of cell play rôles in metastasis that are independent of the anatomy of the parts involved. May we not say that certain organs and tissues of the body possibly carry within their cells a certain susceptibility, probably inherited, for cer-

tain neoplasms, just as certain organs and tissues exhibit great susceptibility for the action of certain drugs?

These considerations must be borne in mind when we are treating carcinoma. We make a five- or ten-year "cure," then a neoplasm appears in the treated field or in some other field. Has a cancer cell lain dormant all these years, or is it a sudden mutation of a cell which carried within itself a something, a susceptibility, to change into a life of malignant riotry? If so, we must do something more than surgery or radiation to prevent the handing down of the disease to posterity. The generation involved must not reproduce, or, according to Slye, it must be bred out with immune individuals for two generations.

But the present religious, moral, and social attitude of the race forbids anything of this kind. To gain a knowledge of heredity in the human would mean the education of the people to the necessity for periodical health and general postmortem examinations, and the control of reproduction. This, of course, is not likely to take place for several generations yet, though there is already much sentiment for birth-control, which, if intelligently carried out, would be in the right direction of progress in cancer control.

There are certain conditions which seem to contain within themselves elements which finally lead to cancer. Xeroderma pigmentosa which appears after the first exposure to sunlight is one of these conditions. The sunlight seems to be a specific irritant or stimulant for assisting in the development of this disease. The susceptibility of the cells is probably hereditary. The sun's rays simply activate the chemical action which changes the susceptibility to an actual malignant change. "Farmer's" or "sailor's skin," with malignant change, develops after long and frequent exposures to the sun's rays. Cancers of the skin also develop after long and constant exposure to certain tars, oils,

and soots. These malignancies are said to be due to chronic irritation, which for many years has been considered as a cause of cancer. Arsenical dermatoses leading to malignancy are similar. Is it not possible that these are *specific* irritations which finally result in cancer in individuals who carry susceptible cells? Be it noted that long exposures to these agents do not always cause cancer. Chronic irritations of a general character do not always lead to cancer, by any means. May not the development of these cancers be ascribed to inherited susceptibility, hastened by specific agents which develop within the cell a chemical or electrical change which is sufficient to overbalance the susceptibility and develop cancer as we know it?

The diagnosis of malignancy of the skin is generally not very difficult, if one checks it with a properly made biopsy studied by an expert pathologist. Without this, many serious mistakes are made, especially by the inexperienced, as well as occasionally by the experienced. When we consider that mistakes of this kind are not easily, if at all, corrected, one must realize the importance of biopsy and expert diagnosis of skin lesions before undertaking any form of treatment.

Lupus vulgaris and erythematosus and tuberculous adenomas, blastomycosis, moles and nevi of various types, sarcoids and morphea, primary or tertiary (gummatous) forms of syphilis and granuloma pyogenicum (especially on the lower lip), sebaceous cysts, keloids, neurofibromas, seborrheic, senile, or actinic keratoses, fatty tumors—all these are often misdiagnosed as malignancies. Not infrequently malignancy develops in a lupus of the skin or a gumma of the tongue, or in a mole or other nevus, keratosis, scar, etc., and must be recognized and receive proper treatment. The first requisite in the treatment of cancer is as thoroughly correct a diagnosis as possible.

The clinical appearance of melanotic growths, together with the very great danger of biopsy or operative interference with the cold knife, must be appreciated. Indeed, we would advise the same caution in connection with any non-pigmented mole or nevus. Such a one often contains metastatic melanotic possibilities not apparent upon microscopic study.

#### BIOPSY

There is an honest difference of opinion about the safety of biopsies in cancer. For statistical purposes, a pre-operative biopsy is essential, but it must be of sufficient area to represent fairly the characteristics of the tumor and its growing border. The French school, headed by Regaud, insists upon a biopsy in every case before applying radium, not alone for statistical purposes, but especially to determine the type and grade and to learn something about the radiosensitivity of the tumor, so that radiation may be applied more intelligently. Most other cancer centers practise biopsy at least for diagnostic purposes. Many radiotherapists advise against it. It has been shown by Wood and others how easy it is to squeeze cancer cells out of the tumor into lymph spaces. It is probable, too, that local anesthetics, injected to relieve the pain of a biopsy, may be the means of forcing cancer cells into the circulation. Personally, we have never had proof of causing metastasis by biopsy, but we have seen many metastatic sequences after operative interference in moles by the cold scalpel. We have not seen metastases follow their removal by surgical diathermy except in one case of melanotic cancer, which recently came under our care. A woman fifty years of age had a black pigmented mole on her temple, which started to grow. She consulted a physician, who destroyed it by desiccation. Three weeks after, when the wound was healed, a second growth appeared alongside



the scar. The patient was then referred to a surgeon, who removed the growth with the radio-knife. Another nodule developed near the scar and one in the eyelid, and she was referred to us. We applied a large radium pack, filtered through 1.5 mm. of platinum and 2 cm. of wax and sawdust, over a large part of the same side of the face and scalp for five days. The tumors disappeared, but three months later another appeared on her leg, and rapidly involved the whole skin and the internal organs. It is probable the original lesion was not treated widely enough, or that the anesthetic was injected too close to the growth. We judge this from the fact that the first secondary growths appeared in the near neighborhood of the primary lesion. No more appeared there after the thorough radium treatment (which, by the way, indicated a sensitivity to radium which is denied by some radiologists to-day).

It has been shown that particles of melanin extend quite a distance in the skin beyond the melanotic growths and rather deeply below the surface, so that these growths would better be treated with radium packs before or after removal, and the surgical diathermy should be of wide and deep extent. This can be done with radio-knife and provide a good specimen for microscopic examination.

In the malignant lymphomas, biopsy is frequently required. Inasmuch as these tumors are probably of lymphocytic origin, and are more or less constitutional, surgical interference with the cold scalpel for biopsy purposes probably makes no difference in the outcome of the disease. The biopsy should be made in practically all cases if the tumor is easily accessible.

#### TREATMENT

The principal methods of treatment in vogue in the last thirty years include the following:

(1) Caustics, such as pyrogallie acid, arsenious acid, zinc chloride, potassium hydrate, freezing with carbonic snow, Sherwell's acid nitrate of mercury treatment after curetting, etc.

(2) Intravenous injections of glandular extracts, serums, toxins, vaccines (Doyen), dyes and other chemicals such as lead, gold, bismuth, etc.

(3) Surgery—by means of the cold knife wide excision, by the radio-knife, fulguration, desiccation, electrocoagulation, actual cautery.

(4) Radiation by X-ray, mesothorium, or radium.

#### CAUSTICS

Caustics of various kinds in the form of pastes, applied without preliminary operative interference such as curettage, have seldom been used during the last few years, except by the quack and illegal practitioners, who continue to attract the credulous and unsophisticated public by their alluring advertising and propaganda.

This treatment could be quite effectual in basal-cell types of growths which do not metastasize, but might be worse than useless in the much more malignant metastasizing squamous-cell, nevo-, or melanotic carcinomas. Likewise, in any of the sarcomas and malignant lymphomas it would be wholly ineffectual. The disadvantages of chemical caustics are: (1) that their action below the surface cannot be very accurately observed or controlled; (2) that they destroy all tissue, pathologic as well as normal, with which they come in contact; (3) that they exercise no influence in involved, but apparently normal, tissue, outside their field of caustic action; (4) that their action is marked by long-continued pain. The action of carbonic snow is too superficial anyway to be considered as an effective agent in any malignancy. With our present-day knowledge of cancer and

effectual means of combating it, we believe caustics should have no place in the armamentarium in the fight against malignant diseases of the skin.

INTRAVENOUS INJECTIONS OF GLANDULAR  
EXTRACTS, SERUMS, TOXINS, VACCINES  
(DOYEN), LEAD, GOLD, BISMUTH,  
AND DYES

For many years all of these agents have been tried in one form or another in cancer, and while occasional more or less reliable reports have been published regarding Coley's toxins and the Blair Bell lead treatment, no authentic reports of cures have been made concerning any of the other agents.

Efforts are being made to find an organ tissue, a dye, or other chemical which may be taken up by the living cancer cell and which will break down its resistance, but as yet there has been no success in this line of research. It is possible that something may be found, which, when injected, may so sensitize or lower the resistance of a radio-resistant cancer that the latter may yield to roentgen or gamma radiation, especially if we can use it in much higher voltage and in much larger quantity of energy, as seems well within the range of possibilities.

SHOULD SURGERY BE EMPLOYED FOR CURE OF  
MALIGNANT GROWTHS OF THE SKIN?

The surgeon for so many generations has claimed this field as his, that it is difficult for him to recognize and yield to a competitor. He has removed and cured permanently many malignancies of the skin, especially of the basal-cell type which are local and consequently more or less benign. With the squamous-cell group and the melanomas he has not been so successful, while the expert radiologist has had real success. The radiologist claims better cosmetic results and is able to combat metastasis quite effectually, in which the surgeon is not successful.

When the metastasis involves the glands of the neck, it is still an open question whether the radiologist or the surgeon has the better success. Certainly the loss of muscular function and the unyielding scar tissue, after such extensive and serious operations on the neck, together with such uncertain final results, produce a picture of convalescence which is to be avoided if possible. The successful results sometimes secured from the heavily filtered radium pack about the glands of the neck are much more pleasing. Improvement in radiation equipment and technic may raise the percentage of cures in such cases.

There is no question but that a growth in the skin itself can be removed by radium or X-ray much more surely and safely and with better cosmetic results than by surgery. In some cases, such, for instance, as those involving the cartilage of the ear or nose, and in some cases of the mouth, better results may be obtained by surgical diathermy—in which latter term we include the radio-knife. If the growth is very small, we use the radio-loop or radio-knife for immediate removal of the whole growth. In growths about the eyelid, Eller highly recommends the super-soft rays (8,000–10,000 volts). We have not had enough experience with these rays in malignant conditions to advise. In melanomas, many—but not all—of which are quite radioresistant, wide and deep removal by radio-knife, together with radium or X-ray, is indicated. Most of this work is done under local anesthesia. In that case, we believe one must be careful to use a block or modified block anesthesia and not inject the fluid into, or very close to, the lesion, for fear of carrying malignant cells into the circulation.

We have found arsenical carcinomas peculiarly resistant to radiation, and surgical diathermy may, by preference, be used in many of these cases if the growths are not too extensively distributed. The

Bowen type, while often quite resistant, usually responds to adequate radiation, as does also the extra-mammary Paget's disease.

We have had one case of adenocarcinoma of the face, of sweat-gland origin—a rare lesion—which was exceedingly radioresistant, and we believe it should have been treated by surgical diathermy at first. It had been diagnosed and operated upon in Scotland as tuberculous a few years before.

We are of the opinion that when the clinical examination and the biopsy show a highly radioresistant type of malignancy in the skin, the lesion would better be removed by surgical diathermy, but not by the cold scalpel. We believe the former method to be safer than the latter. The cells will not be distributed in the circulation or in the wound, at any rate, by a hot knife.

#### RADIATION TREATMENT OF CANCER

Our knowledge of the cause and cure of cancer is still in a condition of flux, and it will probably be many years before the truth concerning the origin and elimination of this disease can be crystallized out of the heterogeneous mass of information that is now being accumulated and will continue to be accumulated in the future. The literature upon this subject during the last few years has been tremendous, and is sufficient to occupy the entire attention of anyone interested. We may be a long way from our goal, but we have gathered together a great mass of data relating to malignancy with which we must familiarize ourselves if we are going honestly and conscientiously to undertake to treat any case of cancer. No conscientious doctor, knowing what is being done to relieve the unfortunate sufferer from this dreadful disease, will lend himself to a scheme to attract patients suffering from cancer by heralding a "cure" which has been untried. It is nothing short of criminal to use one's position and money to

entice suffering and dying persons to come—perhaps from long distances—for a treatment which has little or no evidence behind it to warrant its being used at all. A cure for cancer, if there ever is such a thing as a cure—it is much more likely that there will be *cures* rather than *a* cure—will not be announced out of a clear sky. It will take long and patient experimentation to develop and prove up anything that is going to be of value in the treatment of cancer. Such experimentation has been carried out with X-ray and radium in the treatment of cancer during a period of from thirty to thirty-five years. Innumerable facts of both positive and negative value have been discovered during these years, and now we can truthfully and honestly say, from extensive statistics gathered in many different clinics in different countries, that X-ray, radium, and surgical diathermy offer more hope and encouragement for cancer of the skin than any other treatment known to-day.

Rare, indeed, is the case of cancer of the skin—not too far advanced—which cannot be cured to-day by the expert with the use of X-ray, radium, or surgical diathermy. The great difficulty lies not in the fact that man cannot secure these expensive agents, but rather in his lack of knowledge and experience properly to apply them. It would seem that the time is almost here when the doctor who wishes to treat cancer and who wishes to use such agents as X-ray, radium, and diathermy, will be required to pass a special examination before being permitted to practise in that special field. The ophthalmologists require a special examination before a doctor can become a member of their scientific organization, so technical and specialized is their work regarded: surely it is not any more so than the work of the radiologist and the cancerologist.

For a number of years, statistics have shown that from 85 to 95 per cent of the cases of cancer of the skin may be cured

by X-ray or radium. Of course, those statistics are not accurate, because so much depends upon the type and grade of cancer, as well as upon the stage of its existence, as to what may be accomplished. Whether or not there are such things as pre-cancerous diseases, which may not be the proper term to use, there are certain lesions which are very closely associated with or followed by cancer, as we know it, and which, if removed early in the proper way, will, no doubt, prevent development of the disease, at least at the site of removal. If the disease, whether highly malignant or not—like a squamous-cell carcinoma or a melanoma—is treated early and by proper methods, the percentage of cures should approach close to 100 per cent.

#### SO-CALLED PRE-CANCEROUS LESIONS

*Keratosis*.—These are seborrheic, senile, actinic, or arsenical in origin. If they are accompanied by any irritation of the surrounding or underlying skin, we advise their removal. We generally use X-ray or radium for this purpose—the unfiltered X-ray or the beta and gamma rays of radium. If there is a suspicion of malignancy already developing, and the lesion is less than 2 cm. in diameter, we give a hypermassive dose of unfiltered X-ray, followed by filtered X-ray, every day or two to the area about the lesion, keeping the dose up to saturation for a couple of weeks. Radium can be used similarly without enough filter to stop the beta rays. Arsenical keratoses are often highly resistant to radiation. It is better to use desiccation in these cases. Indeed, desiccation is often the agent of choice in any of the keratoses, whether or not they are becoming malignant. Especially if they have had previous insufficient radiation and have recurred, we think this might be the method of choice.

*Moles*.—We do not hesitate to advise the removal of moles when they are of the type

which projects above the surface, especially when so located that they are subjected to irritation, or if they contain melanotic pigment; but we would caution against removal of such moles with the cold knife, curet, or caustic. We have seen many cases of fatal metastatic melanoma following removal of moles by excision with the knife. We have never, among thousands of cases, seen such a catastrophe follow removal of moles by thorough electrolysis, desiccation, or radio-knife or radio-loop in our own practice. We have seen one such catastrophe follow from a mole of the face which showed irritation for several weeks, but which the patient declined to have removed. Of course, we must bear in mind, as in this case, that malignancies in moles and other nevi may already be microscopically metastatic before any kind of treatment is carried out. Such metastasis may not be discovered until a later development, and perhaps we are not warranted in condemning the use of the cold knife, since in the cases we have observed metastasis might have been present before the operation. However, it is reasonable to suppose that there will be less chance of inoculating the tissue with cancer cells which we cut through with a hot needle, loop, or knife, than with cold instruments. In melanomas, it is our practice, and we believe it is good, to treat a large area about the growth removed with well-filtered X-ray or gamma ray by the saturation method. Melanomas are said to be highly resistant to these rays, a fact which we have found to be true in some, but by no means all, cases, for we have seen metastatic melanomas melt away under roentgen or gamma rays and not recur in the same locality. Therefore, we believe heavy, well-filtered radiation should be given all these melanotic cases and continued daily to saturation for three weeks. Inasmuch as these metastases are blood-borne, we doubt the efficacy of treating the drainage glands, though we often do

it as a precautionary measure. Our practice with all moles is to remove them widely and deeply with the radio-loop or radio-knife, and send the specimen to the laboratory immediately. If we suspect the mole of malignancy before we get the histologic report, or if the latter is positive, we begin radiation treatment at once. If not, we dress the wound daily till it heals, and give no radiation.

#### CLASSIFICATION OF MALIGNANCIES OF THE SKIN

Malignancies of the skin may be classified as follows:

- Basal-cell carcinoma or so-called rodent ulcer
- Squamous-cell carcinoma
- Mixed-cell carcinoma
- Spinous-cell carcinoma
- Adenocarcinoma
- Bowen's disease
- Paget's disease (extra-mammary)
- Nevo-carcinoma
- Xeroderma pigmentosum
- Arsenical cancer
- Melanoma
- Spindle-cell sarcoma
- Round-cell sarcoma
- Kaposi's multiple pigmented hemorrhagic sarcoma

#### BASAL-CELL CARCINOMA

Inasmuch as the basal-cell carcinoma does not metastasize, at least not in its early stage, it is not regarded as very malignant and is generally cured with ease by various surgical or radiological means before it becomes very extensive. The Sherwell method, *i.e.*, by curettage and application of acid nitrate of mercury, is in favor with some dermatologists. However, we must remember that basal-cell growths often arise from more than one center, that they are sometimes of mixed-cell composition, and so may be of metastatic character. Furthermore, the cosmetic results of such treatment

are not so good as by radiation, and the scar tissue resulting will have diminished resistance to cancer cells. Therefore, we claim that thorough radiation of these growths is the method of choice. They may be removed intact by the radio-knife or radio-loop so that their structure is preserved for microscopic examination. Radiation treatment later would depend upon the degree of malignancy found. Their removal should be as complete as possible in the first instance, because, aside from the fact that with insufficient treatment they—as well as other types of malignancy—gain resistance to radiation after insufficient treatment, their increased growth and extension may be very destructive to important organs, especially when they are located near the orbit, the nose, or the ear. The growth may extend into the cartilages and bones, finally destroying them. Oftentimes the entire nose, with its adjoining osseous structures, or the entire orbit, with its contents, or the entire ear are thus destroyed without evidence of metastasis. Basal-cell growths occur most frequently in the face. If these growths are treated by X-ray or radium by hypermassive unfiltered doses, or by X-ray or radium followed by adequate highly filtered doses to the same area and a large area about it, such results can be prevented.

#### METASTASIZING CARCINOMAS

Squamous-, mixed-, and spinous-cell carcinoma, being highly malignant, with a strong tendency to metastasize to the neighboring drainage glands, where they are inaccessible to treatment, will be considered together. They may, for practical purposes, be classed in one group. If the growth is small, it would better be widely removed by radio-knife for microscopical examination. If it is of fairly large size, a section will be sufficient. The wound should receive some electrocoagulation or desiccation in addi-

tion; then radiation should be begun. Inasmuch as these growths often metastasize very early, a large area about the growth, as well as the drainage glands, should be treated by cyto-elective radiation, *i.e.*, by highly filtered rays, at a considerable distance to get the maximum amount of energy at the required depth consistent with the toleration of the skin. This can no doubt be accomplished best with the shorter, more homogeneous wave lengths, such as we get from high voltage, highly filtered X-rays or highly filtered gamma rays. Within certain limits, at any rate, the shorter and more homogeneous the wave length, the better is the skin conserved, and the greater is the depth dose. Hence, we prefer to treat these cases with the highest voltage at present obtainable (said to be 200 K.V., but probably not more than 160 to 170 K.V. in the general run of practice, because the present American tubes will not stand up under greater strain). For this reason, we prefer radium, and follow as closely as possible the Regaud technic. We often give both X-ray and radium, as with this combination we can increase our radiation 30 per cent over what the skin would ordinarily tolerate under the action of one of these agents alone. The difficulty with X-ray is to get a sufficiently short wave length. We have in the X-ray an abundant amount of energy, but lack quality. With radium it is the reverse, so that on account of the inverse square law we must shorten our distance in order to convey into the depth as large an amount of energy as possible, but we are greatly limited here because the skin is necessarily so close to the source of radiation that it suffers disproportionately from a much smaller amount of energy than that which we convey by deep X-ray at a much greater distance, distance being a very important factor.

If we apply a pack of, say, 4 grams of radium at, say, 10 cm. distance, according

to the inverse square law we should have to employ twenty-five times as much radium, namely, 100 grams, to convey the same amount of energy into the tissues if we wish to treat at 50 cm.—the usual deep X-ray therapy distance. This, of course, is not practical at the present time. When we use deep X-ray therapy we follow the Kingery law, as put into practical use by Pfahler, and keep the tissues under saturation for three weeks. If we use radium according to the Regaud method, we continue the application for from five days to two weeks, according to the amount of radium available, the depth of our dosage, and the practical distance at which we may use it. By this method we have been able to make an occasional five-year cure of metastatic squamous-cell carcinoma of the neck.

The only alternative is a block dissection of the neck, which is a serious operation, resulting in much limitation of the movements of the neck and by no means successful in curing metastatic cancer in a great majority of cases. We believe that the best success in these cases will finally come from intensive short wave therapy (at least 500 or 600 K.V.) at a considerable distance—about 50 centimeters. The primary squamous-cell growth in these cases, whether on the lip or some other part of the face, can usually be cured by the X-ray or the radium facilities we have at hand.

#### BOWEN'S DISEASE

The Bowen type of carcinoma is usually quite resistant to radiation but subsides under skillful treatment with X-ray or radium, with or without surgical diathermy. The same may be said of extra-mammary Paget's disease. In the mammary Paget's we have a carcinoma of the breast to deal with and we believe pre-operative intensive and prolonged deep X-ray treatment should be given.

Sarcoma cutis of the round-cell type is more radiosensitive than that of the spindle- or mixed-cell type. These tumors should be treated by deep therapy, X-ray, or radium, and kept up to saturation for two or three weeks.

The multiple pigmented hemorrhagic sarcoma as described by Kaposi is quite radiosensitive, and should be treated by moderately high voltage X-ray, well filtered in moderate doses, repeated as development of the disease demands. Comparatively small doses will cause lesions to disappear. Care should be taken to preserve the normal skin. A permanent cure will probably not be made.

The same may be said of the lymphoblastoma group, but they require different amounts of treatment. Hodgkin's type of malignant blastoma usually requires a larger amount of radiation than the myelogenous or lymphatic leukemias. In all this group, the more homogeneous hard filtered ray is advisable.

We believe we have seen beneficial results in some of these cases from injections of from 50 to 200 microcuries of radium chloride following X-ray.

#### SUMMARY

There is great need for expert specialism in radiological treatment of neoplastic dis-

eases. Special courses and examinations should be requisite for one to practise in these specialties. Local cures of cancer of the skin by modern expert radiation management should approach closely to 100 per cent.

The great importance of biopsy for diagnostic and selective treatment purposes is emphasized. Biopsies are perhaps much more safely performed by means of the radio-knife than by the cold knife. We judge this is especially true in treating melanomas and moles.

The relative values of surgery and radiation in the treatment of malignancies of the skin are discussed, and radiation and electric surgery appear to be of greater value in the treatment of skin malignancies than surgery by the cold knife.

Modern research appears to show rather conclusively that there exists in the cancerous individual a susceptibility of certain cells under some conditions to undergo change to malignant riotry. While radiation or surgery may cure the local condition, the patient is in all probability a carrier of the cancerous tendency to later generations, and so the disease in the race may be stamped out only by breeding it out, as suggested by Slye. This would entail, however, generations of careful ante- and post-mortem examinations.

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# STUDIES OF THE EFFECT OF ROENTGEN RAYS ON THE HEALING OF WOUNDS<sup>1</sup>

## I. THE BEHAVIOR OF SKIN WOUNDS IN RATS UNDER PRE- OR POST-OPERATIVE IRRADIATION

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THE question of the effect of roentgen rays on the healing of wounds is a problem of ever-increasing interest to both the surgeon and the radiologist. A study of the literature discloses a variance of opinion on this subject. It also reveals, however, a scarcity of carefully controlled experiments arranged so as to permit certain comparisons with clinical problems. We feel, therefore, that a discussion of a few selected articles from the recent literature should suffice.<sup>2</sup>

In 1928, Frey (1) exposed the extremities of dogs to filtered roentgen rays of short wave length as used in deep therapy. One group received one erythema dose every four weeks, six times; a second group received one erythema dose every six weeks, four times; a third group received one erythema dose every eight weeks, three times, and the last group received one erythema dose every twelve weeks, twice. The other extremity served as control. Four weeks following the last exposure, the animals were killed and the arteries injected with a contrast medium (minium). Roentgenograms were then taken of the entire extremity and frozen cross-sections made in order to demonstrate the blood-vessel distribution macroscopically. Groups 1 and 2 showed definite blood-vessel injuries, Group 2 less than Group 1. In Group 3 there were only slight changes, and in Group 4 no deviation from the normal could be detected. The lumen of the ves-

sels was narrowed and their number definitely decreased. It appeared that the degree of injury was directly proportional to the total dose applied in a given period; the shorter the interval between the treatments, the greater were the pathologic changes. In another series of experiments the same author tried to determine the time required for the manifestation of the blood-vessel injuries. He exposed one kidney in dogs with 150 per cent E.D., and killed the animals one, two, and three months, respectively, following the treatment. The vessels were visualized by the injection of a contrast medium. After one- and two-month intervals, no macroscopic changes could be seen; the blood vessels of the irradiated kidney appeared to be the same as those of the untreated control. In the animals killed three months after treatment, there were also no macroscopic changes, but following injection it appeared that the number of blood vessels was definitely decreased, particularly in the medulla and the cortex. Frey concludes from these observations that within eight weeks following pre-operative roentgen therapy the surgeon should not encounter any difficulties; there should particularly not be any delay in healing. Since he did not work on wounds, however, his conclusions rest entirely on the supposition that no functional change precedes the actual morphological changes in the vessels.

More recently, Fukase (2) has approached the problem from another angle. He studied the influence of roentgen rays in moderate doses (350 r) on the healing of a simple skin wound in rabbits. From his

<sup>1</sup>Presented before the Radiological Society of North America at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1-5, 1930.

<sup>2</sup>Bibliographies covering the older literature will be found in the papers of Frey (1).



experiments, it seemed that heavily filtered roentgen rays (170 K.V., 0.5 mm. Zn), if given in this dose over a fresh cut through the epidermis down to the cutis, decreased the inflammatory process following the

ical explanation is seen in the inhibitory effect of roentgen rays on leukocytes with oxyphile granules.

The fact that the researches of Frey were limited to the effect of fairly high doses of



Fig. 1. Rat K 1; 100 K.V., 2.0 mm. Al, 1,000 r. One-day E-C interval. Fig. 1-A. Wounds seven days following the incision. Fig. 1-B. Photomicrogram of irradiated part of the cut.



Fig. 2. Rat J 1; 100 K.V., 2.0 mm. Al, 1,000 r. Three-day E-C interval. Fig. 2-A. Wounds seven days following the incision. Fig. 2-B. Photomicrogram of irradiated part of the cut.

trauma; in other words, the irradiated part of the wound healed more quickly than the unexposed control. Less filtered radiation (3.0 mm. Al) at the same potential had hardly any effect. The pathologic anatom-

ical explanation is seen in the inhibitory effect of roentgen rays on the blood vessels only, and that Fukase dealt with doses below those used in malignancies, as, for instance, in pre-operative irradiation of a breast carcinoma, we decided to start a systematic



Fig. 3. Rat D 1; 100 K.V., 2.0 mm. Al, 1,000 r. Seven-day E-C interval. Fig. 3-A. Wounds seven days following the incision. Fig. 3-B. Photomicrogram of the irradiated part of the cut. Fig. 3-C. Photomicrogram of the unirradiated part of the cut.

study of the entire problem. Since a large number of tests seemed to be one of the most essential points in such an investigation, rats were selected for the experiments because they were most available and easily cared for. Furthermore, the toleration of their skin to roentgen rays was well known to us through previous work (3, 4). In this first paper, we have studied the behavior of dorsal skin wounds produced at certain intervals preceding exposure and also following exposure to roentgen rays.

#### METHOD

Adult white rats of the same strain and free from skin lesions were kept in metal cages on a standard rat diet. Before exposure or cutting, the hair was removed from the back in an area of approximately  $8 \times 2$  sq. cm., by clipping, in order to avoid the irritation of shaving. The cuts reached to the external fascia of the dorsal muscles and had an average length of 2 cm. in the case of pre-operative irradiation and of 6 cm.<sup>3</sup> in the rats irradiated following operation. From here on, the procedure differed in the animals treated before (First group) and after (Second group) operation.

<sup>3</sup>It was necessary to place one Michel clip in the center of the cut in order to prevent extensive gaping. Before cutting, the skin was painted with a 2 per cent mercurochrome solution.

In the first group, two fields of  $1 \times 1.5$  sq. cm., with 2 cm. of intervening normal skin, were exposed. The cuts were made 1, 3, 7, 10, 14, 21, and 30 days, respectively, following the X-ray treatment. They left half of each irradiated area intact and extended into the neighboring skin, thus providing two test fields and two controls on each rat. Half the animals were killed seven days following the cutting; the other half as soon as the cuts had completely healed. The skin specimens were then prepared for microscopic examination.

In the second group, one field covering half of the length of the cut was exposed. The average area amounted to  $1 \times 3$  square centimeters. The cuts were made immediately, 24, and 48 hours, respectively, preceding the exposure. A longer interval was not feasible because healing of the wound had progressed by the end of the third day so far as to render impossible the macroscopic evaluation of the influence of roentgen rays on the healing process. Half of the rats were killed seven days following the exposure; the remaining half on complete healing of the cuts. The skin specimens were then prepared for microscopic examination.

Two types of roentgen rays were chosen in order to study, as a secondary question, the influence of the wave length on the biological reaction: (1) 100 K.V., 2.0 mm.

Al, 20 cm. F.S.D.,  $\lambda$  effective 0.34 Å.  
(transmitted through 2.0 mm. Al), 0.7 r  
per second; (2) 140 K.V., 0.25 mm.  
Cu + 1.0 mm. Al, 45 cm. F.S.D.,  $\lambda$

## EXPERIMENTS

The macroscopic and microscopic findings  
will be recorded here, accompanied by a



Fig. 4. Rat D 3; 100 K.V., 2.0 mm. Al, 1,000 r. Seven-day E-C interval.  
Fig. 4-A. Wounds on the fourteenth day following the incision. Fig. 4-B. Photo-  
microgram of the irradiated part of the cut.



Fig 5 Rat F 1; 100 K.V., 2.0 mm. Al, 1,000 r. Ten-day E-C interval.  
Fig. 5-A. Wounds seven days following the incision. Fig. 5-B. Photomicrogram  
of the irradiated part of the cut.

effective 0.18 Å. (transmitted through 1.0  
mm. Cu), 0.2 r per second. The apparatus  
used was a valve tube rectifier with con-  
denser.

number of selected illustrations, since space  
does not permit the reproduction of the en-  
tire material in each group, *i.e.*, both for the  
same quality of radiation and for the same

intervals between the cutting and the exposure. From two to four rats were used in each group in order to allow for individ-

Scar 0.3 mm. wide. New connective tissue, with a few round cells. Beginning hyalinization.



Fig. 6 Rats A 1 and B 1; 100 K.V., 2.0 mm. Al, 1,000 r. Fourteen-day E-C interval. Wounds seven days following the incision. Fig. 6-A Rat A 1. Fig. 6-B Rat B 1.

ual variations. The following report is based on a total of eighty animals.

# I. PRE-OPERATIVE IRRADIATION

## (a) 100 K.V., 2.0 mm. Al, 1,000 r

*One-day E-C<sup>4</sup> Interval.*—Macroscopically there was no essential difference between the two halves of either cut on the seventh day following the cutting (Fig. 1-A). *Microscopic examination:* Depressed wound not epithelialized. Crust remains. Connective tissue growth poor in progress (Fig. 1-B). The wounds were healed on the eighteenth day, presenting a smooth scar throughout the full length of the cut. *Microscopic examination.*<sup>5</sup> Epithelialized, with keratin.

<sup>4</sup>This convenient abbreviation is used throughout the paper for "exposure cutting."

<sup>5</sup>Unless otherwise stated, the microscopic reports refer to sections through the irradiated part of the cuts.

*Three-day E-C Interval.*—No difference could be noticed on the seventh day between irradiated and non-irradiated parts (Fig. 2-A). *Microscopic examination:* Incision gaping; not epithelialized. Considerable crust, in which many polymorphonuclears are found. No acute reaction in tissue. New connective tissue forming (Fig. 2-B). The wounds were healed on the eighteenth day, without perceptible influence of the exposure. *Microscopic examination:* Scar epithelialized, with keratin. New connective tissue, with beginning hyalinization. Width 0.3 millimeter.

*Seven-day E-C Interval.*—In one rat, the cuts showed a slight advance of the healing process in the irradiated part on the seventh day, while in other animals belonging to the same group we could not detect any influence of the exposure (Fig. 3-A). *Micro-*

Al, 20 cm. F.S.D., lambda effective 0.34 Å. (transmitted through 2.0 mm. Al), 0.7 r per second; (2) 140 K.V., 0.25 mm. Cu + 1.0 mm. Al, 45 cm. F.S.D., lambda

## EXPERIMENTS

The macroscopic and microscopic findings will be recorded here, accompanied by a

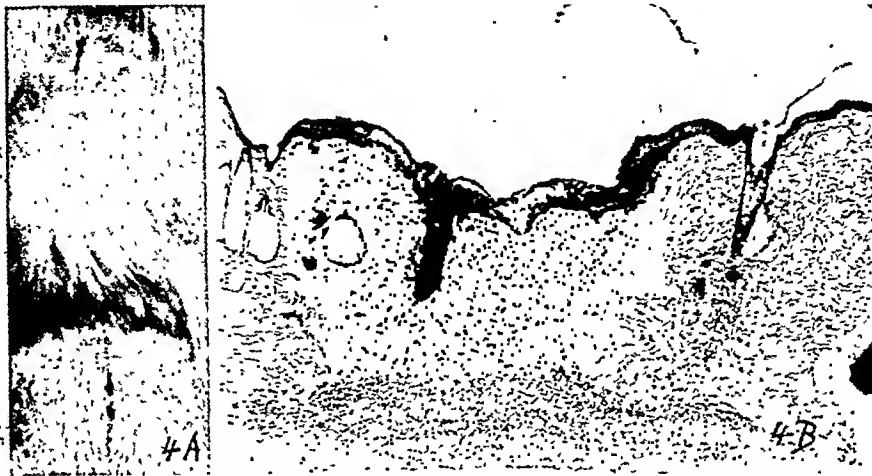


Fig. 4. Rat D 3; 100 K.V., 2.0 mm. Al, 1,000 r. Seven-day E-C interval. Fig. 4-A. Wounds on the fourteenth day following the incision. Fig. 4-B. Photomicrogram of the irradiated part of the cut.



Fig. 5. Rat F 1; 100 K.V., 2.0 mm. Al, 1,000 r. Ten-day E-C interval. Fig. 5-A. Wounds seven days following the incision. Fig. 5-B. Photomicrogram of the irradiated part of the cut.

effective 0.18 Å. (transmitted through 1.0 mm. Cu), 0.2 r per second. The apparatus used was a valve tube rectifier with condenser.

number of selected illustrations, since space does not permit the reproduction of the entire material in each group, *i.e.*, both for the same quality of radiation and for the same

irradiated and unirradiated parts of the cuts. *Microscopic examination:* Cut epithelialized; slight crust. New connective

the fourteenth day, the cuts had healed. *Microscopic examination:* Scar not through muscle. Epithelialized, with keratin. Con-

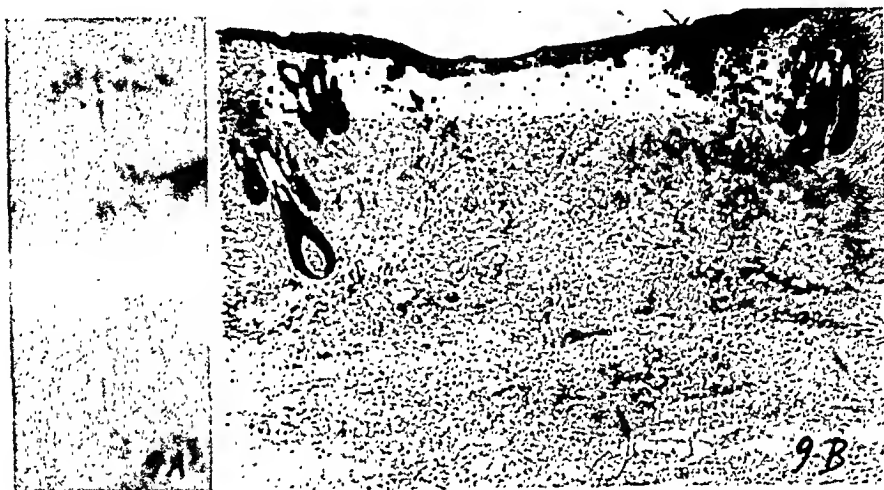


Fig. 9. Rat H 3; 100 K.V., 2.0 mm. Al, 1,000 r. Thirty-day E-C interval. Fig. 9-A. Wounds on the nineteenth day following the incision. Fig. 9-B. Photomicrogram of irradiated part of the cut.

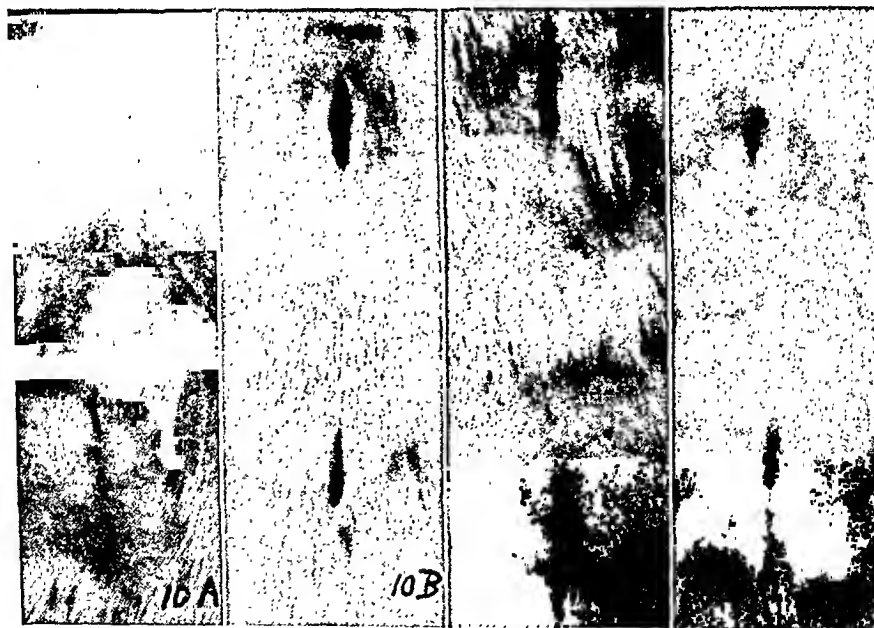


Fig. 10. Rats K 2, J 2, E 2, and F 2; 140 K.V., 0.25 mm. Cu + 1.0 mm. Al, 1,000 r. One-, 3-, 7-, and 10-day E-C intervals. Wounds seven days following the incision. Fig. 10-A. Rat K 2, 1-day E-C interval. Fig. 10-B. Rat J 2, 3-day E-C interval. Fig. 10-C. Rat E 2, 7-day E-C interval. Fig. 10-D. Rat F 2, 10-day E-C interval.

tissue with round cells. No acute reaction. Average width, 0.4 mm. (Fig. 5-B). On

nective tissue is almost completely hyalinized.

*Fourteen-day E-C Interval.*—The cuts were covered by crusts on the seventh day. These were loose in the irradiated parts in some rats (Fig. 6-A), but showed no difference in others (Fig. 6-B). *Microscopic*

than in the previously observed animals. No difference could be detected between treated and untreated parts (Fig. 8-A). *Microscopic examination:* Cut completely epithelialized—crust removed. Scar consists

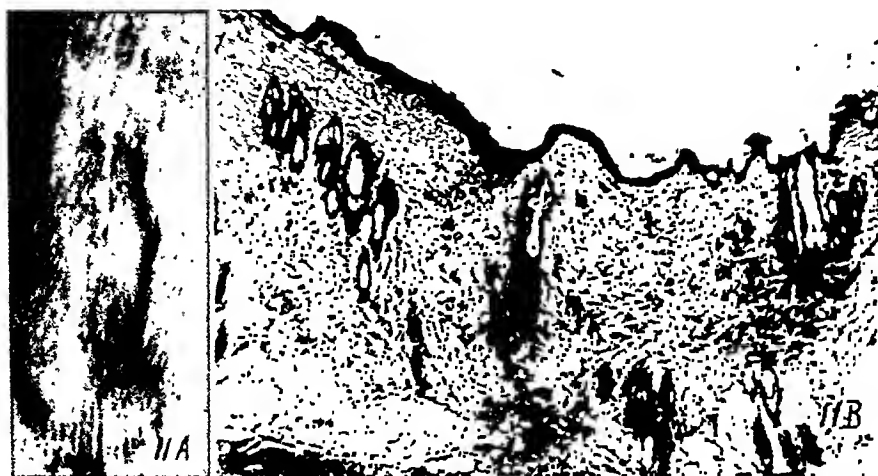


Fig. 11. Rat A 2; 140 K.V., 0.25 mm. Cu + 1.0 mm. Al, 1,000 r. Fourteen-day E-C interval. Fig. 11-A. Wounds seven days following the incision. Fig. 11-B. Photomicrogram of irradiated part of the cut.

*examination:* Incisions healed and keratinized. Epithelium much thicker over wound. Between the twelfth and fourteenth day, the cuts healed uniformly. *Microscopic examination:* Completely healed and keratinized. Scar very narrow. Does not extend through muscle. Occasional polymorphonuclear.

*Twenty-one-day E-C Interval.*—On the seventh day, the healing was well under way, without noticeable difference between the treated and untreated parts of the cuts (Fig. 7-A). *Microscopic examination:* Considerable crust, with partial epithelialization. Poor connective tissue reaction, very edematous (Fig. 7-B). On the fourteenth day, the cuts had healed. *Microscopic examination:* Epithelialized, with keratin. Narrow scar. Partly hyalinized.

*Thirty-day E-C Interval.*—On the seventh day, the cuts were covered by crusts; there was more gaping of the wound

of new vascular connective tissue, with some hyalinization in the deeper layers. No acute inflammatory reaction present (Fig. 8-B). On the nineteenth day, the wounds were well healed without macroscopic changes in the irradiated parts of the cuts (Fig. 9-A). *Microscopic examination:* Fully epithelialized, with keratin. Upper part of connective tissue is partly hyalinized. Considerable round-cell reaction in the deeper layer. A few foreign body giant cells around hairs (Fig. 9-B).

(b) 140 K.V., 0.25 mm. Cu + 1.0 mm. Al, 1,000 r

In this group, the results did not differ in any characteristic manner from those observed in the rats exposed to the radiation of longer wave length. We confine the report, therefore, to the presentation of a few selected photographs and photomicrograms

demonstrating this fact. They were all taken seven days following the cutting.

*One-day E-C Interval.*—*Microscopic examination:* Epithelialized, with keratin. Width 0.3 mm. average. New connective tissue, with a few round cells (Fig. 10-A).

*Three-day E-C Interval.*—*Microscopic examination:* Not epithelialized; crust remains. Considerable fibrin in new connective tissue; 1.0 mm. wide (Fig. 10-B).

*Seven-day E-C Interval.*—*Microscopic examination:* Cut partially epithelialized, with crust. Considerable fibrin and serum remains in deeper layers. No acute reaction (Fig. 10-C).

*Ten-day E-C Interval.*—*Microscopic examination:* Cut epithelialized, with keratin. Scar very narrow and almost completely hyalinized (Fig. 10-D).

*Fourteen-day E-C Interval.*—*Microscopic examination:* Scar epithelialized, with keratin, very narrow (Fig. 11).

*Twenty-one-day E-C Interval.*—*Microscopic examination:* Almost epithelialized. Considerable crust remains. No acute reaction. New connective tissue, considerable edema, and many round cells (Fig. 12-A).

*Thirty-day E-C Interval.*—*Microscopic examination:* Epithelialized. Crust remains. Some acute reaction in upper layers. Considerable fibrin in deeper part (Fig. 12-B).

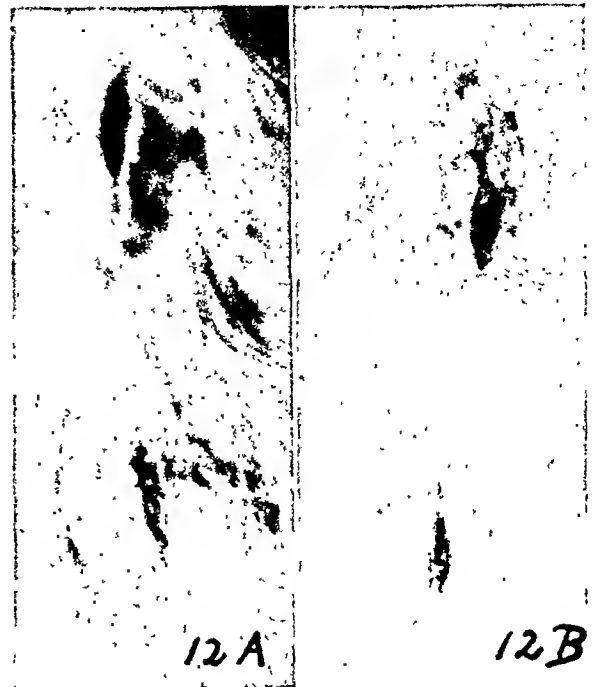


Fig. 12. Rats M 2, H 2; 140 K.V., 0.25 mm. Cu + 1.0 mm. Al, 1,000 r. Twenty-one- and thirty-day E-C intervals, respectively. Wounds seven days following the incision. Fig. 12-A. Rat M 2, twenty-one-day E-C interval. Fig. 12-B. Rat H 2, thirty-day E-C interval.

## II. POST-OPERATIVE IRRADIATION

(a) 100 K.V., 2.0 mm. Al, 1,000 r

*Exposure immediately after cutting.*—Seven days after the cutting, there was a slight retardation of the healing of the irradiated part in one rat, while the others



Fig. 13. Rat X 5, 100 K.V., 2.0 mm. Al, 1,000 r. Exposure immediately after cutting. Fig. 13-A. Wound seven days following the incision. Fig. 13-B. Photomicrogram of irradiated part. Fig. 13-C. Photomicrogram of untreated part.



in our animals did not produce skin reactions of the second or third degree. It was chosen because we knew from tests performed previously that, beginning at about 1,300 r, definite ulceration occurs in the skin of rats. One should logically expect an interference with the healing process of wounds in such an injured skin area. The cuts did not sever the muscle nor were the wounds sutured. With these facts in mind our material will be analyzed.

In the first group, in which the incisions were made in irradiated areas at intervals of from one to thirty days following exposure, it appeared both from the macroscopic and microscopic examinations that there was no definite evidence of retarded healing. The changes due to irradiation, as, for instance, thickening of the capillary walls, mitotic figures in the malpighian layer, and fibroblasts in the corium, have not been mentioned in each case since they repeated themselves throughout the sections. The dose used for both wave lengths corresponded to a threshold erythema for rat's skin, determined and controlled on more than one hundred animals. No effect of the wave length could be detected in any of the tests. If it is permissible to draw any comparisons with our clinical problems, we may assume that moderate roentgen-ray exposure from one to thirty days preceding the operation will not inter-

fere with the healing process in the skin following operation.

In the second group, representing post-operative irradiation, a definite retardation of the healing in the irradiated part of the incision was noticeable. The macroscopic as well as the microscopic studies brought out the fact that exposure twenty-four hours following the incision seemed to have the most pronounced inhibitive effect. After the incisions had completely healed, there appeared to be no difference between the exposed and unexposed parts of the scars. The total healing time varied from 15 to 22 days; in untreated rats, healing usually occurred within from 12 to 15 days. However, we do not wish to place too much value on this time interval. Towards the end of the healing period, it is quite difficult to reach a decision as to the exact date of the healing. Individual observers might easily disagree, since, for instance, a small piece of crust may remain attached for several days in one rat, while in another animal it may sooner become loose, either spontaneously or accidentally. This was most strikingly demonstrated in the first group, in which two cuts on the same rat had been made. Quite often one of these cuts presented a perfect scar from three to four days before the other cut had reached the same stage. Our conclusions rest, there-



Fig. 16. Rat X 12, 100 K.V., 2.0 mm. Al, 1,000 r. Twenty-four-hour C-E interval. Fig. 16-A. Wound on twentieth day following incision. Fig. 16-B. Photomicrogram of irradiated part. Fig. 16-C. Photomicrogram of untreated part.

fore, mostly on the comparisons made on the seventh day. They lead us to believe that if retardation of the healing of the incision is judged to be undesirable, post-op-

ordinary knife. The same observation was reported by Schürch and Tschudi (7), who used, however, radium alone, while Hintze employed both X-rays and radium. The

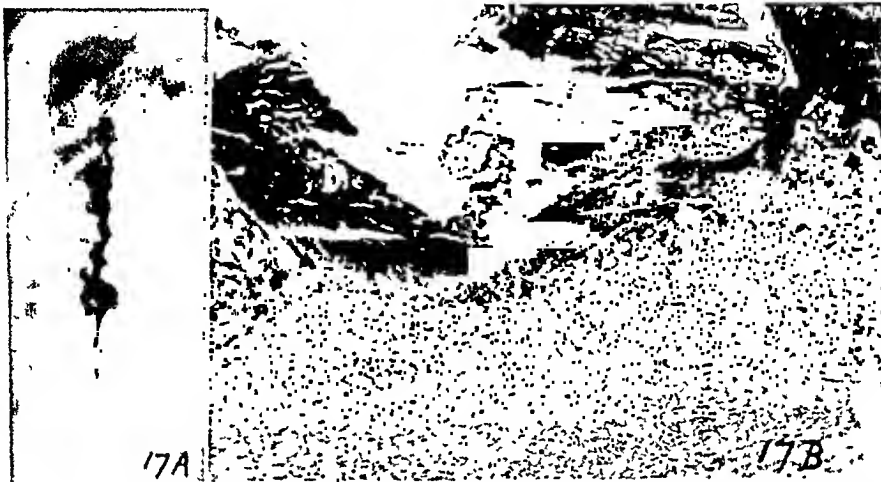


Fig. 17. Rat X 9, 100 K.V., 2.0 mm. Al, 1,000 r. Forty-eight-hour C-E interval. Fig. 17-A. Wound seven days following incision. Fig. 17-B. Photomicrogram of irradiated part.

erative exposure of surgical wounds should be carried out after the scar has been formed. This applies, of course, only to doses of roentgen rays as used in our experiments. However, should the immediate irradiation of the wound be deemed essential, the results of our experiments seem to indicate that a satisfactory scar formation can be expected, provided, again, that no excessive doses of radiant energy are administered. This deduction is borne out by clinical observations. Halberstaedter and Simons (5) found that wounds irradiated after operation showed delayed healing. The final scars were, however, more satisfactory than in the untreated cases. If one-half of an incision following the removal of a malignant tumor had been irradiated, it was noted in one patient that a recurrence appeared in the unexposed half only. According to Hintze (6), the delay is less pronounced if the tissue defect has been made by the electric cautery as compared with the



Fig. 18. Rats X 6 and X 10, 140 K.V., 0.25 mm. Cu + 1.0 mm. Al, 1,000 r. Fig. 18-A. Rat X 6, exposure immediately after cutting. Wound seven days after the incision. Fig. 18-B. Rat X 10, forty-eight-hour C-E interval. Wound seven days after incision.

incision, so that he has almost given up pre- and post-operative irradiation in these cases. Other observers, for example, Dr. Ullmann, with a dose of 800, and another discussant, with 1,000 r applied over the breast, did not

see any retardation at all. I think the best solution of this problem will be to use the results of experimental work with discretion, and proceed then along lines of clinical investigation.

**Principles of Prognosis in Cancer.** William C. MacCarty. *Jour. Am. Med. Assn.*, Jan. 3, 1931, XCVI, 30.

It is a mistake, with present knowledge, to use any one criterion as the basis of clinical prognosis in cancer. It is perfectly legitimate and proper to attempt grading. Clinical and pathologic experience show at least fifteen factors governing prognosis in cancer. They are as follows:

(1) Length of life is inversely proportional to the amount of glandular involvement and distant metastasis.

(2) The greater the fixation of a cancer to surrounding structures the greater the difficulty of surgical removal, the greater the immediate operative risk, and the less the chance for complete recovery.

(3) Malignant or benign tumors so located as to produce early pain, hemorrhage, mechanical obstruction, or an easily recognizable mass are more favorable.

(4 and 5) The lower the cardiac and renal efficiency, the poorer the prognosis, and especially the greater the immediate therapeutic risk.

(6) Anemia is associated apparently with two conditions: reduction of diet; hemorrhage, either single or constant or repeated oozing from the growth. Perhaps a third condition exists, namely, an anemia due to a theoretical toxic condition from the cancer itself or associated with its disintegration. The greater the anemia, the greater the immediate therapeutic risk and the shorter the length of life. That of a single or a recent repeated hemorrhage from the growth may not necessarily

alter the ultimate prognosis after the growth is removed.

(7) It has been established that there is a definite relation between the size and the presence of glandular involvement which, in turn, has prognostic value. The larger the primary growth, the greater the possibility of glandular involvement and hence the worse the prognosis.

(8) Generalizations regarding age alone, when applied to clinical practice, might sometimes be very misleading. It is perhaps correct to say, the younger the patient the worse the prognosis, keeping always in mind that all other factors have an influence regardless of age.

(9) Direction of growth, whether the bulk of the cancerous mass is toward the lumen or surface of the organ or whether it is infiltrating the wall and growing toward adjacent organs or vital cavities is a factor. The latter has the worse prognosis.

(10) As a single prognostic factor, loss of weight is probably of little significance, but taken in association with some or all of the other factors it adds gravity to any prognosis.

(11, 12, 13, and 14) There can be no doubt but that there is some relation between the degree of differentiation of tumor cells and their rate of growth; but size, location, infiltration, glandular involvement and fixation, lymphocytic infiltration, fibrosis, and hyalinization must all be taken into consideration.

(15) In general, the duration of the disease is mainly of value when taken in conjunction with other factors.

CHARLES G. SUTHERLAND, M.D.

# THE TECHNIC OF RADIOGRAPHY BY GAMMA RAYS\*

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**G**AMMA rays can be used in place of X-rays as a means of non-destructive testing of castings and welds for internal defects. It was shown by Mehl, Doan, and Barrett<sup>1</sup> that radiographs can be taken through ordinary sections of steel in a few hours, using as sources of  $\gamma$ -rays amounts of radium readily available at hospitals in the larger cities. The greater penetrating power of  $\gamma$ -rays compared with X-rays was pointed out, and examples reproduced of radiographs taken through thicknesses well beyond the range of usefulness of X-rays at present available.

The apparatus necessary for  $\gamma$ -ray radiography is very simple. A small container of radio-active material is supported rigidly in front of the specimen to be inspected, and X-ray films in suitable holders fastened to the back of the specimens.

Figure 1 shows the experimental arrangement used for taking four simultaneous radiographs of specimens built up of plates. A small glass funnel was used to hold the bulb of radium emanation in the center of the group. In Figure 2 a similar funnel is hung on strings in front of an arm of a forge press, and a film is placed behind it, without removal of the piece. Figure 3 shows the method that was used to explore a large cylindrical casting. Here the source of  $\gamma$ -rays was mounted on a stand within the casting, and films were fastened opposite the source, on the outside. It would have been possible to take radiographs simultaneously on a belt of films extending completely around this casting had it been desired. One of the operators is shown holding a lead-



Fig. 1. Arrangement used to radiograph experimental specimens. (Cf. Figs. 4 and 5.)

lined box containing a bulb of radium emanation eight inches in diameter.

The characteristics of the  $\gamma$ -ray method make it especially applicable to radiographic work through thicknesses above 2 or 3 inches of iron such as are found, for instance, with castings for high pressure steam power plants. When portability is necessary the method is again very appropriate, since no high voltage electrical apparatus is required. A lead-lined room is unnecessary, as the operator's simplest protection from the rays is merely to remain at a distance from the radium during the exposure, and to handle the radium with forceps.

It was the purpose of the previous paper to demonstrate the possibility of  $\gamma$ -ray radiography by exhibiting actual radiographs through a large range of thicknesses of steel, and by theoretical arguments. Such interest has been shown in this possibility, especially among the makers and users of large castings, that a definite technic for taking suitable radiographs is already in de-

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<sup>1</sup>Radiography by the Use of Gamma Rays. Trans. Am. Soc. for Steel Treating, Reprint, Chicago, 1930.

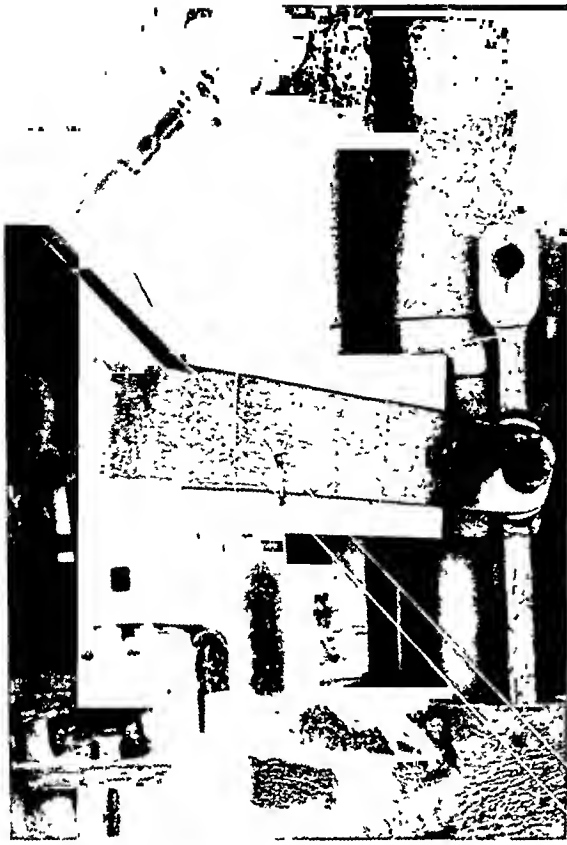


Fig. 2. Glass funnel, supported by strings, holds radium in front of an arm of a forge press for radiographic inspection *in situ*.

mand. From the cost standpoint, the importance of eliminating guesswork is obvious. Radium is not so cheap that its use can be a success in practice if any considerable percentage of radiographs taken with it are failures, or if advantage is not taken of means of increasing the efficiency of the process.

The present paper is an attempt to give definite recommendations and quantitative data for taking  $\gamma$ -ray radiographs. It seems advisable to discuss the physics involved in the technic in some detail; this is done under the headings, "The Source of Gamma Rays," "The Effect of Rays on Films," "Exposures Necessary," and "Scattering of Gamma Rays." In view of the simplicity of both apparatus and operations involved in  $\gamma$ -ray inspection, highly skilled labor seems unnecessary. A simple presentation of a

suitable technic is, therefore, in order, and while it may be lacking under the headings mentioned, the division "Operations in Practice" is intended to fill this need.

The difficulty of reproducing radiographs for publication is well known. A tremendous range of densities may be satisfactorily recorded on a film, but only a few appear on a print. To illustrate points in the discussion below, however, it is necessary to reproduce some actual radiographs regardless of the quality of the reproduction. This has been attempted in Figures 4 to 9, through photography of the original films placed on a viewing frame and illuminated by diffuse light from the rear. In some cases increased contrast has been obtained through the use of Process film and contrast printing; in other cases it was necessary to reduce contrast and suffer a corresponding loss of detail. No retouching has been done.

#### THE SOURCE OF GAMMA RAYS

The only radio-active material of practical importance seems to be radium; there are considerable amounts<sup>2</sup> of this distributed in several cities in the United States and used for medical purposes.

Radium decomposes at a constant rate into the gas radium emanation, which, in turn, produces a series of decomposing solids, some of which give off  $\gamma$ -rays.<sup>3</sup> The strength of these rays is proportional to the amount of radium emanation present. If the emanation is left in contact with the radium from which it forms, it builds up until equilibrium is reached, when its rate of formation equals its rate of decay, and its strength is then proportional to the amount of the radium. The amount of emanation in equilibrium with one gram of radium, as

<sup>2</sup>Figures do not seem to be available as to the amount of radium in the country. No radium has been produced in this country since 1925, but the U. S. Department of Commerce has estimated that 45 or 50 grams were imported during the years 1924-1929, and we understand it is being imported at an increasing rate.

<sup>3</sup>Practically all the gamma rays effective in radiographic work arise from the disintegration of Radium C.

measured by the intensity of the  $\gamma$ -rays emitted, is called a curie.

Radium emanation may be pumped from the parent radium, and sealed in small glass bulbs. In this form its strength decreases so that the intensity  $I$  of X-rays at any moment is  $I = I_0 e^{-\lambda t}$ , where  $t$  is the time interval that has elapsed since the intensity was  $I_0$ , and  $\lambda$  is a constant, equal to 0.007551, when  $t$  is measured in hours.

Table I gives values hourly for  $\frac{I}{I_0}$ .

Either radium or radium emanation may be used for radiography, but the necessary exposure times are different. When radium is used one has a source of a constant intensity, and the exposure obtained is proportional to the product of intensity and time,  $I_0 t$ . With emanation as a source the exposure is proportional to the integral of intensity with respect to time, *i.e.*,

$$\int_0^t I dt = I_0 \int_0^t e^{-\lambda t} dt = \frac{I_0}{\lambda} (1 - e^{-\lambda t}).$$

With the use of this formula Table II has been computed, giving the number of hours' exposure necessary with emanation to produce a result equal to a given number of hours' exposure with radium, when the strength of the emanation in millicuries at the beginning of the exposure is equal to the number of milligrams of radium. For example, if one desired exposure of 1,200 milligram-hours, it could be had with 100 milligrams of radium in 12 hours, 200 milligrams in 6 hours, etc.; but reference to Table II shows that if one started with 100 millicuries of emanation it would require 12.6 hours, or, starting with 200 millicuries, 6.1 hours would be necessary.

A less accurate method of calculating exposures is to assume that the decay is linear with time and that the mean strength of the emanation during an exposure is simply the average of the initial and final strengths. The errors in such calculations are negligible



Fig. 3. Radiographing a large cylindrical casting. Radium is held on a stand inside and films are fastened outside. (Cf. Fig. 9.)

in practice unless exposures are many hours long.

TABLE I.—DECAY OF RADIUM EMANATION\*  
(for  $\lambda = 0.007551$  hrs.; half life = 3.825 days)

| Time<br>$t$ | Intensity<br>$e^{-\lambda t}$ | Time<br>$t$ | Intensity<br>$e^{-\lambda t}$ | Time<br>$t$ | Intensity<br>$e^{-\lambda t}$ | Time<br>$t$ | Intensity<br>$e^{-\lambda t}$ |
|-------------|-------------------------------|-------------|-------------------------------|-------------|-------------------------------|-------------|-------------------------------|
| 0           | 1.0000                        |             |                               |             |                               |             |                               |
| 1           | 0.9925                        | 13          | 0.9064                        | 25          | 0.8278                        | 37          | 0.7560                        |
| 2           | 0.9850                        | 14          | 0.8996                        | 26          | 0.8216                        | 38          | 0.7504                        |
| 3           | 0.9786                        | 15          | 0.8929                        | 27          | 0.8155                        | 39          | 0.7448                        |
| 4           | 0.9703                        | 16          | 0.8861                        | 28          | 0.8093                        | 40          | 0.7391                        |
| 5           | 0.9629                        | 17          | 0.8795                        | 29          | 0.8032                        | 41          | 0.7336                        |
| 6           | 0.9557                        | 18          | 0.8729                        | 30          | 0.7973                        | 42          | 0.7282                        |
| 7           | 0.9485                        | 19          | 0.8662                        | 31          | 0.7911                        | 43          | 0.7225                        |
| 8           | 0.9413                        | 20          | 0.8597                        | 32          | 0.7852                        | 44          | 0.7171                        |
| 9           | 0.9343                        | 21          | 0.8533                        | 33          | 0.7793                        | 45          | 0.7117                        |
| 10          | 0.9272                        | 22          | 0.8468                        | 34          | 0.7734                        | 46          | 0.7064                        |
| 11          | 0.9203                        | 23          | 0.8405                        | 35          | 0.7676                        | 47          | 0.7010                        |
| 12          | 0.9134                        | 24          | 0.8343                        | 36          | 0.7620                        | 48          | 0.6960                        |

\*Meyer-Schweidler, "Radioaktivitat," Teubener, Berlin (1927), page 419.

#### EFFECT OF RAYS ON FILMS

In both X-ray and  $\gamma$ -ray work where but a minute fraction of the radiation passing through a film is absorbed by the emulsion, any method of increasing the photographic effect of the rays is of great practical importance. Eastman Superspeed Duplified X-ray films, with their large grain size and double emulsion are very fast. Overdevelopment further increases their speed. Satisfactory development technic consists of

developing in the standard Eastman X-ray Developer to which 20 milligrams of potassium iodide per liter have been added, for twice the length of time recommended for ordinary X-ray work at the various tem-

Secondary electrons ejected by the  $\gamma$ -rays are more completely absorbed in the emulsion than the  $\gamma$ -rays themselves, so that a copious emitter of secondary electrons in contact with the emulsion can considerably

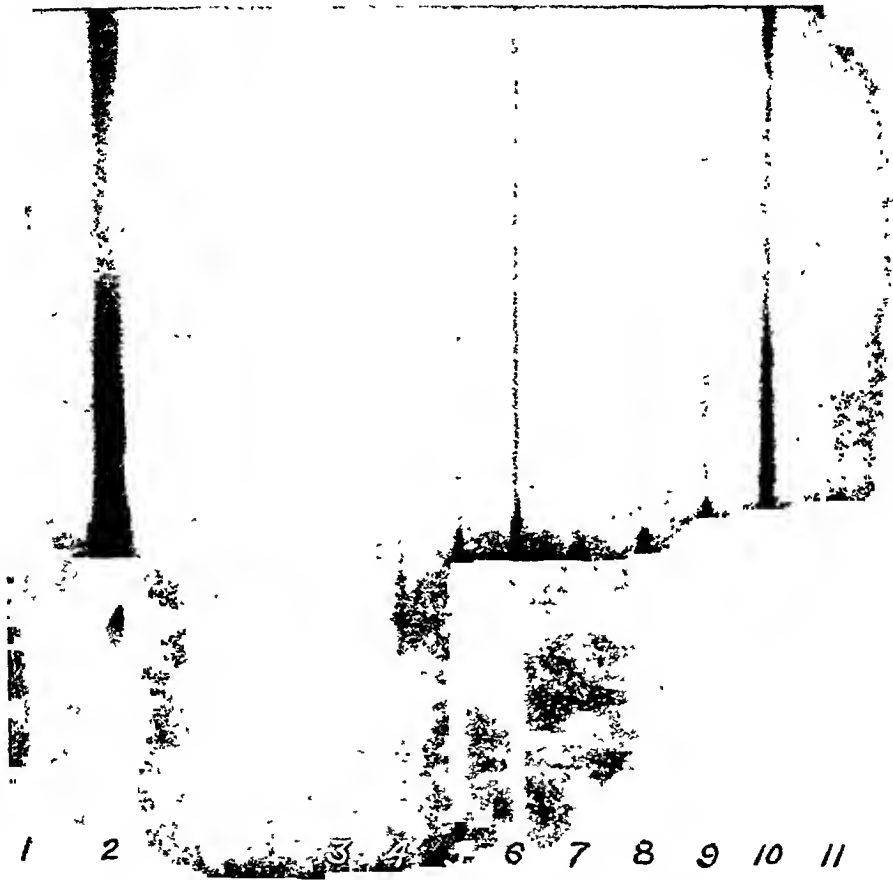


Fig. 4 Radiograph of slotted steel plate arranged as shown in Figure 1. Total thickness, 4 inches; distance, source to film, 18 inches; exposure, 3,050 milligram-hours, using three lead intensifying screens with two films. Dimensions of slots as follows, from left to right:

|              |    |    |   |   |   |    |   |     |     |    |   |
|--------------|----|----|---|---|---|----|---|-----|-----|----|---|
| Width in mm. | 13 | 6  | 1 | 1 | 1 | 1  | 2 | 2   | 2   | 2  | 3 |
| Depth in mm  | 13 | 13 | 2 | 3 | 6 | 12 | 2 | 3.5 | 6.5 | 12 | 2 |

peratures.<sup>4</sup> For example, at 65° F. development may be prolonged to ten minutes, the potassium iodide preventing excessive fog. This technic was used throughout the work reported in this paper.

increase the efficiency of the film. Lead foil<sup>5</sup> placed on both sides of the film was found to shorten the exposure times for  $\gamma$ -rays as it is commonly known to do for X-rays.

<sup>4</sup>A chart of standard developing times is given in "X-rays in Industry," Eastman Kodak Co., 1929

<sup>5</sup>The foil used was General Electric X ray Corporation's "X ray Foil," 0.006-inch thick.

TABLE II.—COMPARISON OF EXPOSURE TIMES  
IN HOURS FOR RADIUM AND FOR RADIUM  
EMANATION OF EQUAL INITIAL  
STRENGTH

| Ra-<br>dium | Emana-<br>tion | Ra-<br>dium | Emana-<br>tion | Ra-<br>dium | Emana-<br>tion | Ra-<br>dium | Emana-<br>tion |
|-------------|----------------|-------------|----------------|-------------|----------------|-------------|----------------|
| 1           | 1.0            | 11          | 11.5           | 21          | 22.8           | 31          | 35.4           |
| 2           | 2.0            | 12          | 12.6           | 22          | 24.0           | 32          | 36.6           |
| 3           | 3.0            | 13          | 13.7           | 23          | 25.3           | 33          | 37.9           |
| 4           | 4.0            | 14          | 14.8           | 24          | 26.5           | 34          | 39.3           |
| 5           | 5.1            | 15          | 15.9           | 25          | 27.7           | 35          | 40.6           |
| 6           | 6.1            | 16          | 17.0           | 26          | 29.0           | 36          | 42.0           |
| 7           | 7.1            | 17          | 18.2           | 27          | 30.2           | 37          | 43.4           |
| 8           | 8.2            | 18          | 19.3           | 28          | 31.5           | 38          | 44.8           |
| 9           | 9.3            | 19          | 20.5           | 29          | 32.8           | 39          | 46.2           |
| 10          | 10.4           | 20          | 21.6           | 30          | 34.0           | 40          | 47.6           |

Definite measurements are available on the intensity of this secondary electron emission under various conditions. Eve<sup>6</sup> measured with an electroscope the intensity of the electron emission from sheets of different elements for  $\gamma$ -rays filtered through 2 cm. of lead, separating the emission from the two sides of the sheets. The ionization in his electroscope due to electrons coming out of the side of the sheet upon which the  $\gamma$ -rays were incident as plotted in Figure 10 as the "incidence" curve, while the curve marked "emergence" gives the ionization caused by emission from the side of emergence of the  $\gamma$ -rays.<sup>7</sup> The preponderance of emission in the emergence direction for light elements has its explanation in the quantum theories of radiation. As the atomic number of the screen is decreased, an increasing proportion of the secondary electrons is made up of electrons recoiling under the impact of the quanta of  $\gamma$ -rays, which they deflect, or "scatter." These recoiling electrons obey the laws of conservation of energy and momentum in the impact and thus always go in the forward direction, in fact, with  $\gamma$ -rays, nearly all proceed at an angle less than  $45^\circ$  from the direction of motion of the primary  $\gamma$ -ray. With the heavier elements, on the other hand, the recoil electrons become

few in number compared with photo-electrons. Photo-electrons result when the  $\gamma$ -ray quanta are absorbed instead of deflected, and have a distribution in space quite different from that of the recoil electrons, so that the total emission from heavy elements is approximately the same from the incidence and emergence sides. The emergence ionization as a function of thickness of the sheet is plotted in Figure 11 for aluminum and lead from measurements by Bragg.<sup>8</sup> The ionization increases with thickness until the electrons starting at the incidence side of the sheet are unable to reach the emergence side; further increase in thickness simply reduces the intensity of the  $\gamma$ -rays without adding to the number of electrons emitted.

On the basis of Figures 10 and 11 then, the best foils to put in contact with double-emulsion films for  $\gamma$ -ray work would be lead for the side farther from the radium, and lead or aluminum on the near side; the lead foil should be from 0.2 to 0.4 mm. thick for maximum effect, and the aluminum 2 mm. or more. An actual test with X-rays through 4 inches of steel with 2 mm. aluminum, 0.15 mm. lead, and 0.3 mm. lead on the radium side of films proved that lead is preferable to aluminum both for speed and definition; 0.15 mm. of lead appeared slightly more effective than 0.3 millimeter.

Materials which fluoresce under the action of  $\gamma$ -rays can be made into effective intensifying screens as has been done for X-ray radiography. Calcium tungstate screens are satisfactory in the  $\gamma$ -ray region, although their effectiveness in shortening exposure times for  $\gamma$ -rays is not as great as for high voltage X-rays. When used with X-rays their intensifying action increases with the hardness of the rays; that this increase does not continue into the  $\gamma$ -ray region of wave lengths is seen from the measurements of Figure 12. Scattered  $\gamma$ -rays reaching the

<sup>6</sup>A. S. Eve: *Philosophical Magazine of London, Edinburgh, and Dublin*, 1909, XVIII, 275.

<sup>7</sup>No importance should be attached to the actual values of the ionization plotted here, for an unknown but constant amount must be subtracted from these values to correct for ionization from causes other than those here discussed.

<sup>8</sup>W. H. Bragg and J. P. V. Madsen: *Philosophical Magazine of London, Edinburgh, and Dublin*, 1908, XVI, 918.



film from the rear, in radiographic work, are considerably longer in wave length than the original  $\gamma$ -rays and might fall within the range of greatest intensifying action for calcium tungstate screens. If this were the

with a hole 1 inch in diameter extending through it was used to collimate a beam of  $\gamma$ -rays from 250 millicuries of radium emanation placed at the bottom of the hole. The films under test were placed on the top



Fig. 5. Radiograph of drilled steel plate, shown in Figure 1, with total thickness of  $1\frac{1}{2}$  inches; distance, source to film, 18 inches; exposure, 175 milligram-hours, using three lead screens and two films. Dimensions of holes: (top row) 1 inch diameter;  $1\frac{1}{2}$  inches, 1 inch, and  $\frac{3}{4}$ -inch deep: (middle row)  $\frac{1}{2}$ -inch diameter;  $\frac{5}{8}$ -inch,  $\frac{1}{2}$ -inch, and  $\frac{3}{8}$ -inch deep: (bottom row)  $\frac{1}{2}$ -inch diameter;  $\frac{1}{8}$ -inch,  $\frac{1}{8}$ -inch, and  $\frac{1}{8}$ -inch deep.

case it would be doubly important to shield radiographic films from side and rear scattering when using such screens.

The characteristics of Eastman Super-speed Dupli-tized X-ray films under various conditions are shown in Figure 13. The method of obtaining the data was as follows: A lead cylinder 8 inches in diameter

of a block of iron 1 inch thick placed over the hole, and were 9 inches from the radium. Exposures of from 1 to 32 minutes were made and the films over-developed with the technic described above. Densities of the unexposed film and the exposed spots were calculated from measurements on a Kipp and Zonen microphotometer by taking

the logarithm to the base of the ratio of intensities of light passing through an undeveloped, fixed, washed, and dried film, to the intensity of the light passing through the film whose density was desired. That is, the density was taken as

$$\log_e \frac{\text{light incident on the emulsion}}{\text{light transmitted by the emulsion}}$$

The density due to the fog alone (amounting to about 1.15) was then subtracted from the densities of the exposed portions for each film and the difference plotted against the exposure time in Figure 13. The results show films surrounded by two Patterson screens to be the fastest of those tried, then, in order, one Patterson screen and one lead screen, two lead screens, and finally plain film without screens. Radiographic exposures made with two Patterson screens require about 0.6 the time required without screens, while with two lead screens this fraction is about three-quarters.

In all our radiographic tests we have used duplicate films. There is a considerable advantage in making a simultaneous exposure on two films; not only may the exposure be shortened, but, perhaps more important than that, the irregularities in the emulsions originating in manufacture and subsequent handling do not occur in the same spots on both films and are, therefore, averaged out. A great deal more confidence is felt in interpreting a faint marking as caused by a defect in a radiographed specimen if the same marking is seen on two films. The advisability of using more than two films appears questionable to the authors, however. The "confidence factor" does not increase appreciably, and the density due to the fog alone, with all the films combined, becomes too great—at least with the developing technic used in this work. Of course, the film costs also increase with the multiplicity of films used.

Two arrangements found convenient when using a pair of films are: lead—film—

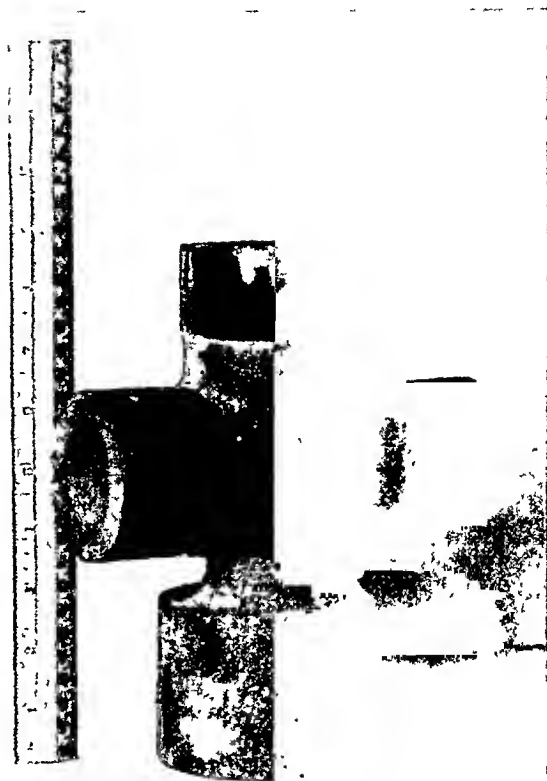


Fig. 6. Photograph of bronze valve casting of which radiograph is shown in Figure 7.

lead—film—lead, or when using fluorescent screens: screen—film—lead—film—screen. With these arrangements the films are separated only by the thickness of one lead sheet, and are contained in a single film holder, two conditions that are obviously desirable.

#### EXPOSURES NECESSARY

Upon penetrating a substance  $\gamma$ -rays decrease in intensity by absorption and scattering. The rate of decrease appears different when measured with different arrangements of apparatus. This has been shown to be the effect of varying amounts of the scattered rays reaching the measuring instrument along with the primary rays.<sup>9</sup>

<sup>9</sup>For summaries of this work see Rutherford: "Radioactive Substances and Their Radiations," Cambridge, 1913, pages 258-263; Meyer and Schweidler, "Radioaktivitat," pages 149-156; Handbuch der Experimental Physik, XV, 70-74.



Fig. 7. Radiograph of bronze valve casting shown in Figure 6. Distance, source to film,  $27\frac{1}{2}$  inches; exposure, 1,600 milligram-hours; two lead screens; one film. Several flaws are visible in the original film.

The position of radium, specimen, and film in radiography is a particularly poor one for getting the true rate of decrease of the primary ray since the film receives a maximum amount of the scattered rays. Therefore, accurate measurements of true absorption, made with the absorbing screen near the radium and far from the measuring device to eliminate the effect of scattering, cannot properly be used to calculate the intensity striking the film in a radiographic exposure.

Absorption measurements under conditions approximating those of radiography were made by Soddy and Russell,<sup>10</sup> K. W. F. Kohbrausch<sup>11</sup> and others. It was found that the intensity of a ray of original inten-

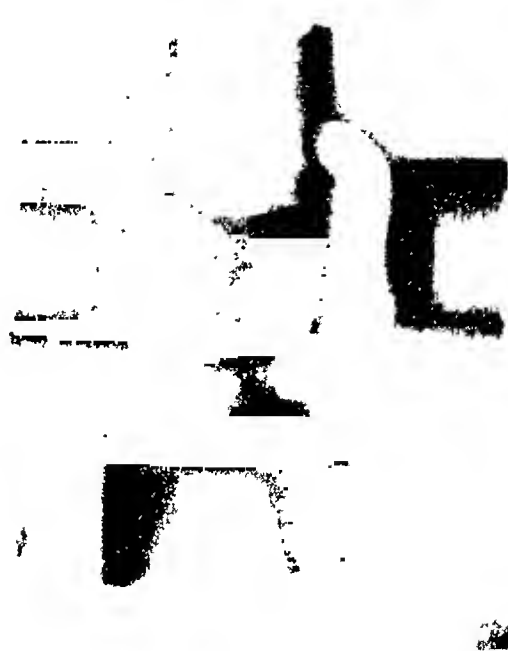


Fig. 8. Radiograph of a machined bronze valve casting. Distance, source to film,  $27\frac{1}{2}$  inches; exposure, 1,600 milligram-hours; two lead screens; one film.

sity  $I_0$  after passing through a thickness  $x$  of a metal of density  $\rho$  was

$$I = I_0 e^{-\mu x} = I_0 e^{-\left(\frac{\mu}{\rho}\right) \rho x}$$

where  $\mu$  is the linear absorption coefficient and  $\left(\frac{\mu}{\rho}\right)$  the mass absorption coefficient. Some values found for these coefficients are given in Table III. Soddy and Russell

TABLE III.—ABSORPTION COEFFICIENTS FOR  $\gamma$ -RAYS FROM RADIUM ACCORDING TO SODDY AND RUSSELL

| Metal | $\mu$ (cm. <sup>-1</sup> ) | $\mu/\rho$ |
|-------|----------------------------|------------|
| Fe    | 0.304                      | 0.0399     |
| Cu    | 0.351                      | 0.0398     |
| Brass | 0.325                      | 0.0389     |
| Al    | 0.111                      | 0.0401     |
| Pb    | 0.495                      | 0.0434     |

found a constant value of  $\mu$  in lead from 2 to 22 cm. thick, and similarly found constant values over large ranges of thickness in other materials. Later observers were

<sup>10</sup>F. Soddy and A. S. Russell: *Philosophical Magazine of London, Edinburgh, and Dublin*, 1909, XVIII, 620. Mr. and Mrs. Soddy, and A. S. Russell: *Philosophical Magazine of London, Edinburgh, and Dublin*, 1910, XIX, 725.

<sup>11</sup>Summarized: *Handbuch der Experimental Physik*, XV, 71.

able to detect a hardening of the rays as they penetrated greater thicknesses, caused by the more rapid absorption of the softer components, and resulting in a progressive decrease in  $\mu$  with increasing thickness, an effect doubtless hidden from the earlier investigators by the presence of considerable

varies with the thickness according to the relation

$$t = t_0 e^{\mu x} = t_0 e^{\left(\frac{\mu}{\rho}\right) \rho x}$$

where  $t_0$  is the time required with  $x = 0$ . The derivation of this equation assumes (1)

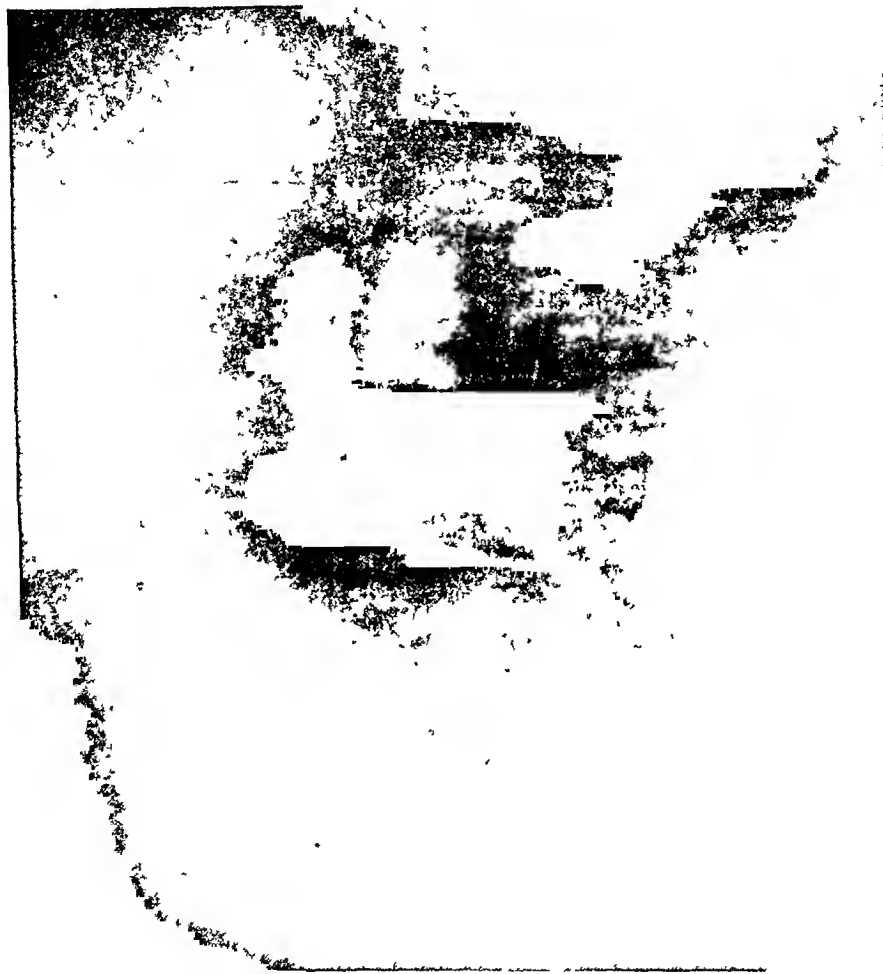


Fig 9. One of the radiographs of the large casting shown in Figure 3. A long crack, slightly obscured by streaks due to irregularities in the surface of the casting, is seen below and to the right of the lead identification figure "2". Exposure, 5,100 milligram-hours, with three lead screens, two films; distance, source to film, 31 inches.

scattering in their work. Taking the simple exponential equation above as representing absorption in radiography, the exposure time required to give a certain density on a photographic film behind  $x$  cm. of metal

that a constant source of intensity is used, (2) that the effect on a film is the product of intensity times time, a valid assumption, and (3) that the film is completely protected by lead shields from scattered rays reaching

it from the rear (excited by primary rays striking the walls, floor, etc.).

As there was some doubt as to just how well the above formula and values of Table III would serve to establish radiographic ex-

cient accuracy since only the position of the curve along the time axis, not its shape, is affected by the thickness of the absorbing plates. The time required to give any desired degree of blackening could then be

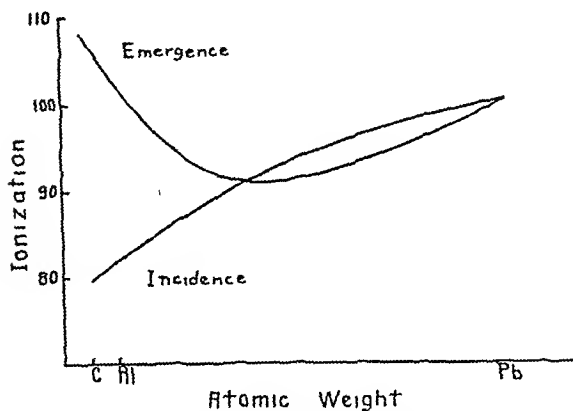


Fig. 10. Ionization produced by secondary electrons from screens of various atomic weights when radiated by gamma rays from radium (A. S. Eve).

posure times, it was decided to determine exposure times under actual conditions.

Steel plates 12 inches square and steel disks 16 inches in diameter were arranged about a holder of radium emanation as shown in Figure 1. Films were shielded from  $\gamma$ -rays scattered from walls and floor by lead sheet  $\frac{1}{8}$  inch thick shown tied to the back of the piles of plates. Various slots and holes were cut in the plates next to the emanation to test the thickness of defect that could be detected. A distance of 18 inches from source to film was used throughout the test. With a given thickness of plates and type of intensifying screen two exposures were made and the density measured at points on the films corresponding to the full thickness of metal. The exposure times actually used were transformed to the times that would be required for corresponding exposures with 100 milligrams of radium. Plotted on semi-logarithmic paper these times and densities, for a given thickness, gave two points on a curve of the type shown in Figure 13. These points located the time-density curve with suffi-

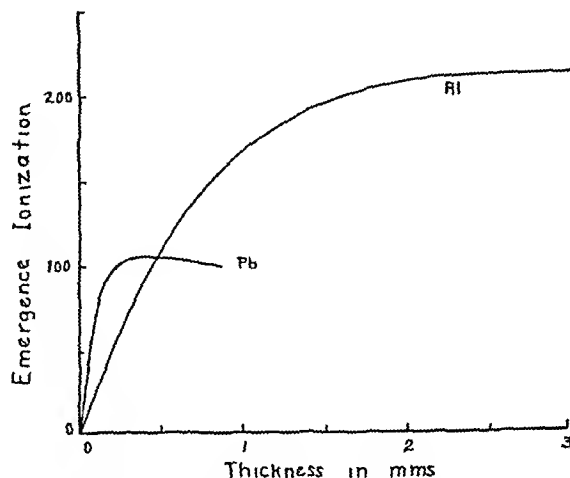


Fig. 11. Ionization on the emergent side of screens of various thicknesses, when radiated by gamma rays of radium (Bragg and Madsen).

read from the curve. Such exposures were used that the desired point lay either between the two used, or very close to one.

The proper amount of blackening for radiographs has been studied in detail by Neeff<sup>12</sup> but it is difficult to believe that the optimum density for viewing small changes in density of a film is independent of the intensity of the viewing light, as he appears to assume. For viewing two superimposed films, each of which shows rather more fog than usual because of the method of overdevelopment used, the optimum density recommended by Neeff can hardly be given much weight. We have chosen a density, including fog, of 2.20 (in natural logarithms); with this blackening flaws 2 to 3 per cent of the specimen's thickness are seen with specimens from 2 to 6 inches thick.<sup>13</sup>

<sup>12</sup>Th. Neeff: *Ztschr. f. tech. Physik*, 1925, VI, 208-216; reviewed by Glocker: *Materialprüfung mit Röntgenstrahlen*, Springer, Berlin, 1927, pages 65-69.

<sup>13</sup>In the absence of scattering, the ability to detect a hole is independent of the thickness of the specimen, since it leads to an increase in the intensity reaching the film by a factor of  $e^{\mu d}$  where  $d$  is the depth of the hole and  $\mu$  the absorption coefficient of the metal. In practice, this relation does not hold, for scattering is present and is a function of the thickness.

This density is suitable for viewing two superimposed films simultaneously and is also satisfactory for viewing a single film in close contact with white paper by reflected light.

blackening was that expected within the limit of accuracy of the experiment. This rule is convenient when making up a plaster to coat the surface of an irregular casting for the purpose of eliminating shadows of

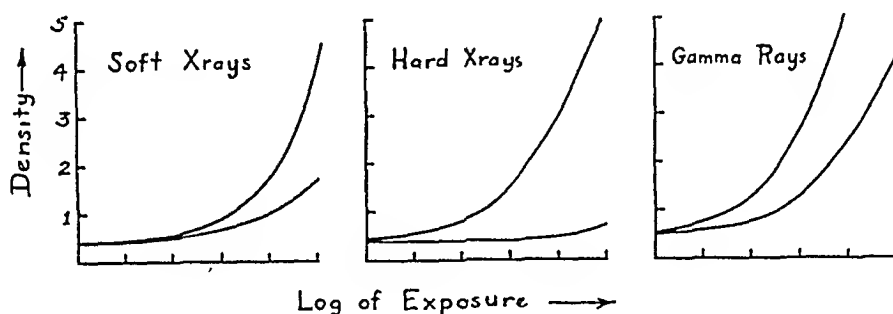


Fig. 12. Effect of Patterson screens on film density with radiation of different wave lengths. Upper curves, density with screen; lower curves, density without. Soft X-rays from molybdenum tube at 30,000 volts, A.C.; hard X-rays from tungsten tube at 140,000 volts, D.C., filtered through 4.5 mm. copper; gamma rays from radium emanation filtered through 1 inch of iron.

The results of the test are given in Figure 14. For thicknesses above two inches the slope of the curves has been made to correspond to a linear absorption coefficient of  $\mu = 0.304$ , in agreement with Soddy and Russell's value (Table III). Curves are given for two arrangements of screens and one density; data for other screens or other densities can be obtained from these by multiplying the exposure times by suitable factors (equivalent to a displacement of these curves along the axis of abscissas).

It will be seen from Table III that the mass absorption coefficient,  $(\frac{\mu}{\rho})$ , has nearly a constant value for different elements. From the exposure time equation above it is seen that the following convenient approximate rule can be formulated: the exposure necessary for  $x$  inches thickness of a metal of density  $\rho$  is the same as that necessary for  $\rho x / 7.8$  inches of steel, where 7.8 is the density of steel. This was tested with aluminum ( $\rho = 2.7$ ) by giving a 5-inch thickness the exposure necessary for  $2.7 \times 5 / 7.8 = 1.73$  inches of iron; the resulting

surface defects from the radiograph. Any plaster will do that has the same density as the casting.

The exposure necessary for a radium-to-film distance of  $d$  inches can be obtained from the exposure at 18 inches by multiplying the latter by  $(d/18)^2$ . The distance used in practice will depend upon the number and size of objects that are to be radiographed at one time and upon the definition—the sharpness of the image—that is desired. The smaller the source and the greater its distance from the defect, the greater the sharpness of the defect's shadow. Another important advantage obtained with a greater distance is a more uniform intensity over the area of the film. For the most economical use of radium, the objects to be tested should be placed about the radium to cover the greatest possible fraction of the total solid angle about it; they may be placed at such distances that the various thicknesses reach their completed exposures in the same number of hours. When the whole of the spherically radiated energy from the radium

The proportion of scattering at large angles increases with increasing wave length and is one of the causes for the need of careful shielding of the film when using X-rays. The Bucky diaphragm, a device of

a given point in a specimen being radiographed. Taking measurements of Compton's<sup>15</sup> we have estimated the relative intensity of scattered  $\gamma$ -rays reaching different points at the rear of a lead sheet 1 inch

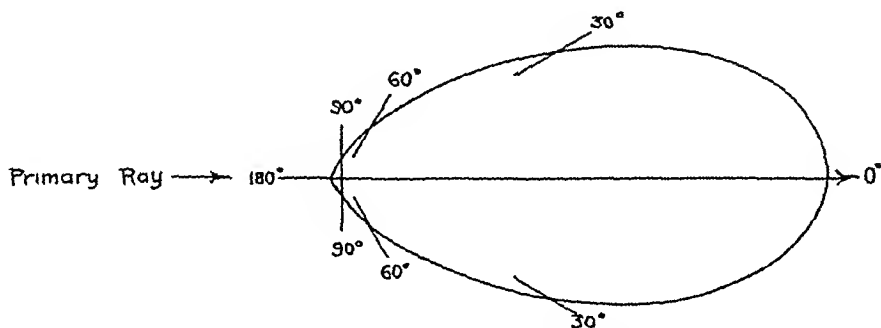


Fig. 15. Distribution in angle of intensity of gamma rays from radium scattered by iron (A. H. Compton).

multiple slits placed between the specimen and the film and very useful in radiography of the human body with the long wave lengths necessary for that purpose, could not be expected to add much to the quality of  $\gamma$ -ray radiographs. Its purpose is to prevent radiation scattered at an angle greater than a certain given angle from reaching the film. It is, therefore, an artificial method of producing a distribution of scattered rays of the favorable type shown in Figure 15 and would naturally be most effective when the original distribution differed most from this, *i.e.*, with soft X-rays.

The wave length of the scattered rays is another factor to be considered, for it is much greater than that of the primary rays. If the primary wave length be taken as 0.010 Å.u., then a ray scattered at 90° has a wave length of 0.034 Å.u. and at 180°, 0.058 Ångström unit. With this increase in wave length goes a decrease in the hardness of the ray. This is so pronounced that at large angles of scattering the rays are no harder than high voltage X-rays.

Knowledge of these factors enables a calculation to be made of the area of film which will be fogged by the scattering from

thick, assuming a small element of volume on the radium side of the sheet as the only source of scattering. Because of the distribution-in-angle of intensities, the softening upon scattering, the different thicknesses traversed by the scattered rays, and the weakening according to the square of the distance from the source of scattering, this element of volume can cause fogging over a circle only an inch or so in diameter, as shown in Figure 16. (The intensity of the primary ray is not indicated in the figure.) While this example represents a simplified case not found in practice, it is sufficient to show an important point, namely, that a specimen of great length and breadth can be radiographed with practically no more fogging from scattering arising in the specimen than one would experience with a small specimen of the same thickness.

For best results films should be shielded from scattered rays reaching them from the rear (originating in the walls and floor of the room), although the amount of this is not excessive. Figure 4 taken through 4 inches of steel had part of the film pro-

<sup>15</sup>A. H. Compton: *Philosophical Magazine of London*, Edinburgh, and Dublin, 1921, XLI, 749.

tected from this rear scattering by an  $\frac{1}{8}$ -inch thickness of lead; another part was protected by a  $\frac{1}{4}$ -inch thickness. As is seen, the fog was reduced by the  $\frac{1}{8}$ -inch sheet, but no further reduction was effected by the additional  $\frac{1}{8}$ -inch.

#### OPERATIONS IN PRACTICE

An imaginary case will serve to illustrate the process of taking  $\gamma$ -ray radiographs with the technic recommended above and will indicate the simplicity of the method. Let us assume that radiographs are to be taken of two castings, one of steel of maximum thickness (in the direction it is desired to send the rays) of 4 inches, the other of bronze of maximum thickness 3 inches, and suppose that the source available for the work is radium emanation of strength 350 millicuries at the time the exposure is to start, enclosed, say, in a small needle-shaped container.

The initial cost of lead foil for intensifying screens is much less than that of calcium tungstate screens. The choice between these two types will depend on whether the saving in radium costs through the use of the more efficient calcium tungstate screens will pay for their greater initial cost. In this example we will assume lead foil is used, and that properly designed film holders are on hand. A desirable arrangement in each film holder is to alternate two films and three lead screens.

The source assumed, being needle-shaped, amounts to nearly a point source if viewed from the ends, so the most advantageous position for the two castings is in line with the axis of the needle. Their distance from the needle will now be considered. The greater the sharpness desired in the radiographs, the greater must be the distance from source to film and the smaller must be the dimensions of the source. Larger films require greater distances than small

films, in order to have uniform blackening over the surface of the film. Suppose comparison with previous results indicates the source-to-film distance should be at least 18 inches (a distance found satisfactory in the

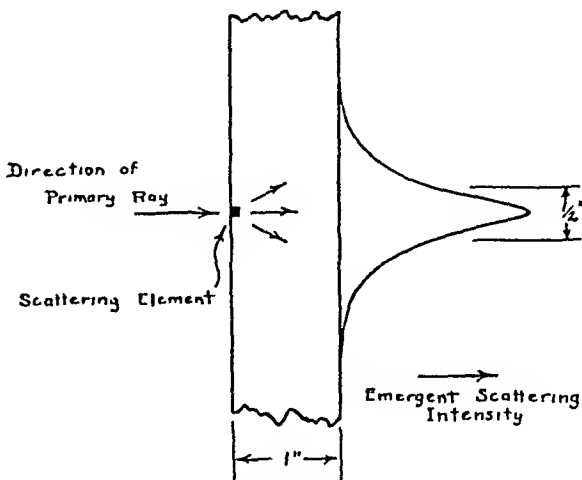


Fig. 16. Distribution of intensity over the back of a lead block, of gamma rays scattered by an element of volume in the front surface of the block.

work in this Laboratory). The exposure may then be calculated for the larger casting using this distance.

From the chart of Figure 14 the exposure for 4 inches of steel at 18 inches with lead screens and Eastman Dupli-tized X-ray film is seen to be 21 hours for 100 milligrams of radium, or  $21 \times \frac{100}{350} = 6.0$  hours for 350 milligrams. The equivalent exposure using radium emanation of 350 millicuries strength at the beginning of the exposure is obtained from Table II and is 6.1 hours.

The bronze casting may be placed at 18 inches and its exposure time calculated, or it may be placed at such a distance that it will require the same length of time as the steel casting. The latter scheme is often more convenient and will be assumed in this illustration. The thickness of 3 inches assumed for bronze is first to be reduced to its equivalent thickness of steel by multiplying by the density of the alloy and dividing by



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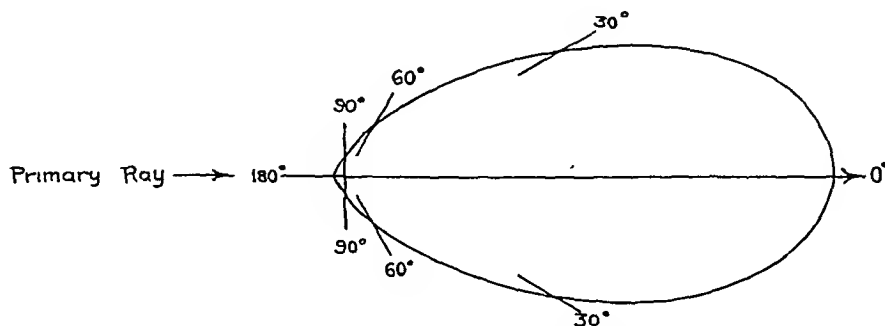


Fig. 15. Distribution in angle of intensity of gamma rays from radium scattered by iron (A. H. Compton).

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<sup>15</sup>A. H. Compton: *Philosophical Magazine of London, Edinburgh, and Dublin*, 1921, XLI, 749.

# GASTROJEJUNOCOLIC FISTULÆ<sup>1</sup>

By H. W. WIESE, B.S., M.D., St. Louis, Missouri

OUR attention has recently been called to the condition of gastrojejunoecolic fistula by the appearance of a case on the medical service of Barnes Hospital. This patient presented characteristic symptoms and X-ray findings, and was subjected to successful surgical treatment. Upon review of our hospital records another case was found which had been admitted with a clinical diagnosis of purpura. In the latter instance the patient died within twelve hours of admission to the hospital and the fistula was not suspected until the autopsy.

## SUMMARY OF CASES

Case 1. A. C., aged 31, a white male, married, was admitted to Barnes Hospital from the Outpatient Department in October, 1929. He complained of diarrhea, of pain in the abdomen, and also of pain in the muscles.

*Past history:* The patient had had frequent attacks of tonsillitis, and a peritonsillar abscess three years before admission. Fifteen years previous to the present examination he began having a burning pain in the epigastrium two hours after meals. This was relieved by food and soda. He was treated medically for several years, without relief. In 1923 he had a gastroenterostomy, after which his symptoms improved but he was not entirely free of discomfort. In 1925, the pain again becoming quite severe, the man received hospital treatment for thirty-four days on a rigid ulcer régime. He then followed a similar but ambulatory régime for two years, with considerable benefit, but upon resuming a normal diet, the severe symptoms returned. He then resorted to a diet of his own choos-

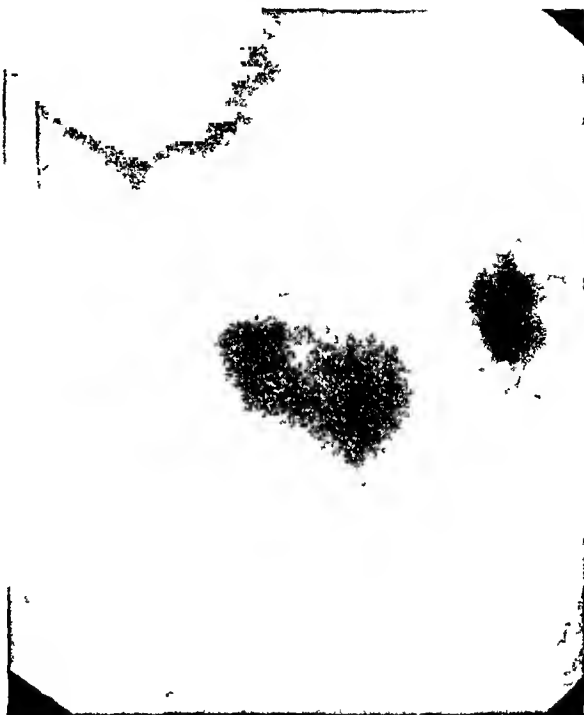


Fig. 1 Case 1. The opaque meal showing the filling of the distal transverse colon via the gastrocolic fistula.

ing and was quite comfortable until the onset of the condition from which he now sought relief.

The present illness began six months previous to admission, with a diarrhea which resulted in five or six stools each night, and two or three stools each day. The fecal matter was watery and contained some mucus. There was cramping in the lower abdomen below the site of his original ulcer pain. He consulted a physician and underwent a gastro-intestinal X-ray examination, but no abnormality was found. He was given a diet and an antacid. The diarrhea increased, with three or four stools at night and ten to twelve during the day. Fourteen weeks before admission he became too weak to work and was confined to bed. Two weeks later, he began to have a dull aching pain,

<sup>1</sup>From the Department of Medicine, Washington University, and Barnes Hospital, St. Louis, Mo



Fig. 2. Case 1. The opaque enema showing the canalization of the gastrocolic fistula, and the filling of the stomach from the colon.

in the arms and legs, not localized to the joints. Two weeks after that, edema of the ankles and puffiness of the face appeared. Hemorrhoids developed. Seldom was there fever. He had lost twenty pounds in weight during the past six months. The appetite remained good throughout.

The physical examination revealed a pale, poorly nourished man, without fever. Eyes, ears, nose, throat, lungs, and heart were not notably other than normal. The blood pressure was 132 mm. systolic and 88 mm. diastolic. The abdomen showed an upper right paramedian scar of an operation for gastro-enterostomy, and a scar of an appendectomy at the McBurney site. There was a slight diffuse tenderness in the right upper quadrant.

The red cells were 3,370,000; the white cells 9,100, and the hemoglobin 70 per cent. The blood Wassermann and Kahn serum reactions were negative. The non-protein blood nitrogen was 26 mgm. per 100 cubic centimeters. A gastric analysis revealed much

mucus and debris in the contents of the fasting stomach, without free hydrochloric acid, and a combined acidity of 1 degree. A guaiac test for occult blood was faintly positive. At 20 minutes after the test meal the free acid was 10° and the combined acid 1°; at 40 minutes, free acid and the combined acid were 2° and 1°, respectively, and at 60 minutes 5° and 2°, respectively. The stool gave a moderately positive guaiac reaction for occult blood. The urine was negative. The roentgenologic examination showed the gastric clearance to be occurring *via* three openings: the pylorus seemed to have ready clearance; the gastro-enterostomy was functioning, and a gastrocolic stoma canalized readily. The duodenal cap was atypical in shape but without any irritability suggestive of an active ulceration. The second duodenum was markedly hypotonic. A barium enema readily canalized the gastrocolic fistula and the stomach filled promptly by this means.

At an operation Oct. 17, 1929, by Dr. Glover H. Copher, the scar of the original ulcer was found in the first portion of the duodenum. The loop of the jejunum distal to the gastro-enterostomy was inflamed and adherent to the colon. A gastrojejunocolic fistula was made out. The jejunum was separated from the colon, and the opening in the colon was sutured. The gastro-enterostomy was separated, the stomach closed, and a portion of the jejunum was excised and continuity restored. The post-operative course was uneventful and the patient was discharged from the hospital Nov. 15, 1929, and has since been observed in the Outpatient Department. During the first three months post-operative he gained thirty pounds in weight, and he has been entirely free of all symptoms.

Case 2. W. A. R., aged 61, a white male, single, was brought into Barnes Hospital Nov. 25, 1928, in a comatose condition. Because of this, it was impossible to secure a

detailed history. It was determined that he had had typhoid at the age of 20, pneumonia at 21, and that ten years previously he had been operated upon in New York City for a duodenal ulcer. During the past five

technique on the under-surface of the nose. The gums, and the hard and soft palates showed many purpuric spots. There was a definite purpura over the entire trunk. A few moist râles were found in the base of

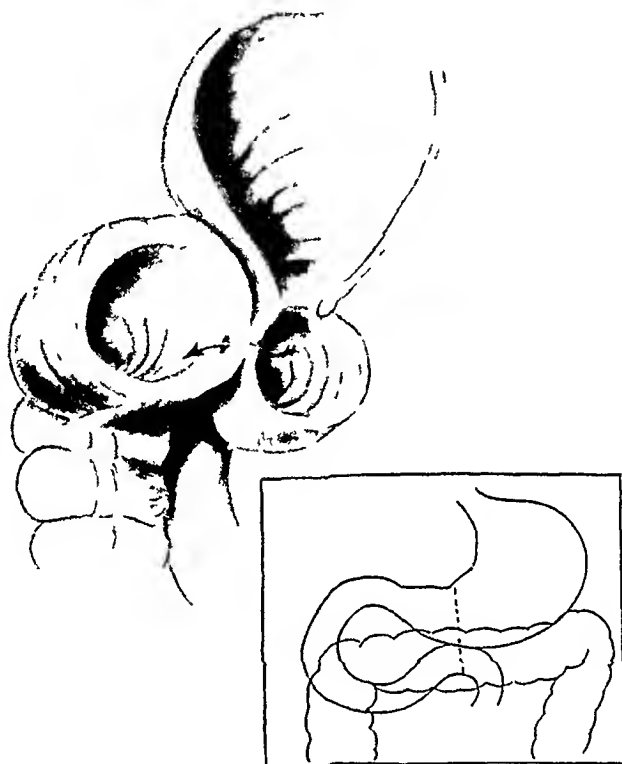


Fig 3 Case 1 Sketch showing the fistula and the relations of the segments as found at operation

years, he had had five or six bowel movements a day. The stools did not contain blood or mucus. During the five weeks prior to admission to the hospital he had received "serum treatment" in a clinic not affiliated with this institution.

A physical examination showed a stuporous patient having a temperature of  $36^{\circ}$  C. and a pulse of 140, which was weak and irregular. The pupils were small, and the right was, besides, slightly irregular and gave no reaction to light. There were pe-

both lungs. The blood pressure was 60 mm. systolic and 40 mm. diastolic. The abdomen showed a long upper right paramedian scar, but otherwise was not notable. Rectal examination revealed a slightly enlarged prostate. There was a distinct swelling in the midline of the perineum, with some tenderness and no redness.

The red blood count was 3,550,000, the white cells were 18,400, and the hemoglobin 60 per cent. The blood Wassermann and Kahn reactions were negative. The non-

protein blood nitrogen was 125 mgm. per 100 cubic centimeters. A blood smear showed only slight irregularity of the red cells. A fair number of platelets were visible. With catheterization, much blood drained out, reducing the mass in the perineum, and the catheter had evidently entered a blind cavity.

The patient's condition became rapidly worse and he died the morning after admission.

At autopsy the only findings referable to the subject of this paper was an anastomosis of the posterior wall of the stomach to the first part of the jejunum. The distal stomach had been partially resected. The proximal duodenum was buried in the pancreas. The transverse colon was firmly adherent to the gastro-enterostomy. After the stomach was opened a finger could be passed readily into the colon as well as into the small intestine.

Prior to 1903, 70 cases of gastrocolic fistulæ were reported, which had developed secondary to carcinoma of the stomach or of the colon. Haller (1) reported the first case in 1755 and Murchison (2) reported the first group, numbering 33, in 1857. In 1897 Bec (3) increased the group to 63, and in 1903 it was further increased to 70 by von Koch (4). The first case of gastrojejunal fistula was reported by Czerny (5) in 1903. This fistula followed the operation of gastro-enterostomy for gastric ulcer. The report appeared four years after Braun (6) had first described a case of gastrojejunal ulcer, in 1899. In 1921 Loewy (7) compiled from the literature a group of 76 cases of gastrojejunal fistula. By that time 185 instances of gastrocolic fistula of various types had been reported. In 1925 Verbrugge (8) compiled from the previous literature 202 cases of gastrocolic and gastrojejunal fistulæ. Seven among these had been reported from the Mayo Clinic. To these he added 14 cases from that Clinic. Of this total of 216, 95 had

followed upon a gastrojejunal ulcer, which had developed at a posterior gastro-enterostomy. The other 121 cases occurred in the course of primary abdominal disease. Since 1925, there have appeared in the literature 30 more cases, of which 22 occurred after gastro-enterostomy done for peptic ulcer and 7 from carcinoma of the colon or of the stomach. One was said to have been due to a "misadventure." Of the fistulæ following upon gastro-enterostomy, six were reported by Macdonald (9), three by Brock (10), and one each by DeJardin (11), Bradbury (12), Shangle and Beisler (13), Cabot (14), Kauffheil (15), Küttner (16), Wittkowsky (17), Robertson (18), Shore (19), Monroe and Emery (20), Pratt (21), and Lahey and Jordan (22). Of the fistulæ resulting from cancer, Brock (10), Hill (23), and Lambret and Razemon (24) each reported one, and Dickson (25) reported four, together with a case caused from a jejunal ulcer and another due to "misadventure," as mentioned above. The two cases of gastrojejunal fistula reported above occurred after gastro-enterostomy for duodenal ulcer and bring the number in that category up to 119, and the total of all types to 248.

Gastrocolic and gastrojejunal fistulæ, resulting from malignancy either of the stomach or of the colon, are becoming less frequent because of the earlier diagnosis of cancer. On the other hand, fistulæ following gastro-enterostomy have become more frequent. The chief factor in the etiology of the latter type of fistula is the occurrence of a perforation of a gastrojejunal ulcer, and the incidence is considerably less than that of these ulcers, which is given in the American literature (excluding the figures of Lewisohn) as from 2 to 5 per cent of all gastro-enterostomies, and in the German literature as from 5 to 10 per cent. They occur eleven times more often in men than in women, and Verbrugge found that of the

patients seen at the Mayo Clinic who had a gastrojejunal ulcer, 11.36 per cent developed a gastrojejunocolic fistula. Bolton and Trotter (26) found 10 per cent in a similar analysis and Lion and Moreau (27) 12 per cent.

The symptoms are fairly well represented in Case 1. Quite often, in addition to the diarrhea, cramping, and loss of weight, there is feculent eructation or vomiting. These symptoms vary in degree according to the size and directness of the fistula. The diarrhea may be of sudden onset in the course of a syndrome characteristic of marginal ulcer. The stools are liquid, contain undigested food, little mucus, and no pus or blood. They do not resemble those of colitis. However, one of the cases reported above was treated elsewhere upon that diagnosis. The absence of diarrhea does not contradict the diagnosis. Monroe and Emery (20) have reported two cases which were unusual in that neither had this symptom. The eructation or vomiting of fecal material varies with the directness of the opening, but is usually present in some degree. Pain is rare. The pain of the marginal ulcer is generally relieved after the fistula occurs, and may be replaced by a different, usually cramping, discomfort, lower in the abdomen than was the ulcer pain. The loss of weight varies and may be considerable in case the condition fails of early diagnosis and resultant starvation and dehydration continue.

The diagnosis may be made from these symptoms, together with the history of an antecedent gastro-enterostomy, with or without the symptoms of gastrojejunocolic ulcer, or with the history of malignancy of the stomach or of the colon. The diagnosis is confirmed—and when the symptoms are of minor degree it is made—by the roentgen demonstration of the opening between the segments. This may be difficult and inconclusive in case the tract is small and indirect, and it may be necessary to use a dye,

which, after ingestion with food, may appear promptly in the stool, or may be recovered by tube from the stomach when administered with an enema.

The treatment of the condition is surgical, the extent and nature of the procedure depending upon whether the segments are to be merely separated and closed, or the gastro-enterostomy, when present, be left, restored, or disconnected.

It appears evident that the factors which allow the development of a gastrojejunocolic fistula are those of the origin of the marginal ulcer. These may be enumerated as (1) carelessness in post-operative management; (2) causes similar to those of the original peptic ulcer; (3) the use of unabsorbable sutures; (4) trauma of the mucosa at operation, and (5) an inadequate position and patency of the stoma. Undesirable circumstances in the manner of treatment of the transverse mesocolon in performing a posterior gastro-enterostomy should be considered among the factors both of the marginal ulcer and of these fistulæ. The fistulous opening into the colon is a fortuitous occurrence in the penetration and perforation of the marginal or jejunal ulcer, and is classified according as the stomach and jejunum are separately or jointly involved in the opening. The communication may be so direct that there is scarcely any appreciable fistulous tract. This was the condition in the first case reported. On the other hand, the communication may be small and intermittently patent or have a valve action. This situation lessens the characteristic symptoms and makes the diagnosis of the condition more difficult.

#### SUMMARY

1. Two cases of gastrojejunocolic fistula following gastro-enterostomy for duodenal ulcer are reported.
2. The literature has been reviewed and 30 cases of gastrocolic fistula collected, of

which 22 were gastrojejunal in type, following upon a gastro-enterostomy for peptic ulcer.

3. The condition may remain unrecognized, as in the second case, and may be susceptible to most successful treatment, as in the first.

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## RIGHT DIAPHRAGMATIC HERNIA<sup>1</sup>

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THE patient whose case report introduces this paper was a female 72 years of age, who was admitted to the hospital on Dr. Sansum's service, complaining of obesity, constipation, and rheumatism. Her history was negative for trauma. She had undergone a cholecystectomy at the age of 52 and had gone through nine normal pregnancies.

Physical examination showed dullness over the right lower chest, with absence of breath sounds over this area. During fluoroscopy incidental to an orthodiagram an enlarged heart was noted and a shadow seen in the right lower chest. She was referred to the Roentgen Department for chest study. This showed a moderate left ventricular enlargement, with a dense shadow in the lower half of the chest. The heart was displaced slightly to the left. No respiratory excursion could be seen on the right side. The upper zone of the shadow showed an air-containing viscus, and on the chance that this might represent gas-containing loops of bowel a barium meal was given to rule against a diaphragmatic anomaly (Fig. 1).

An intrinsically sound normal stomach and cap were visualized. The pyloric portion of the stomach and the duodenum were seen to be lower than the usual position in a patient of this habitus. The cap was large and flaccid, instead of being of the small round or flat type usually seen in stout patients (Fig. 2).

Twenty-four hours after the barium meal the head of the column was in the descending colon and the tail in the cecum. The entire hepatic flexure, including most of the transverse colon, was seen to lie in the right

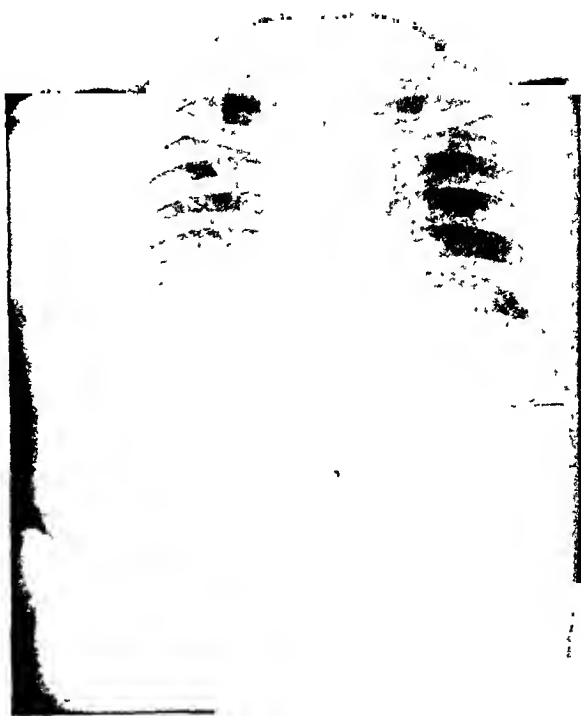


Fig. 1. Roentgenogram showing a high diaphragm and gas-filled loops of colon.

thorax, extending up to the level of the second rib anteriorly. Except for its position and a few diverticula, the colon was normal (Fig. 3). The tip of the cecum was seen to lie a few centimeters above the iliac crest. The ascending colon entered the thorax just to the right of the esophageal hiatus. No connection with this foramen could be observed either on films or by watching barium pass into the stomach while the colon still contained barium.

The heart film showed what was possibly a thin septum at the upper margin of the shadow, but films made after the colon was filled with barium failed to show evidence of this being the diaphragm. We concluded, therefore, that the wall of the colon, which contained a small amount of gas at

<sup>1</sup>Read before the Radiological Society of North America at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1-5, 1930.



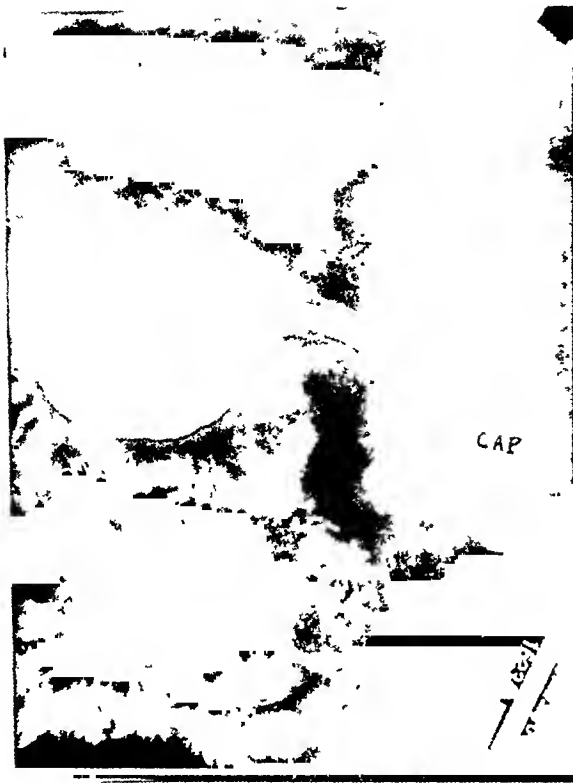


Fig 2. Roentgenogram showing filled stomach and cap after the barium meal.

the first examination, accounted for this shadow. The condition was, therefore, regarded as a hernia rather than as an eventration of the diaphragm. Furthermore, the upper level of the shadow lacked the characteristic bow-shaped contour seen with eventration.

Anomalies of the diaphragm consist of eventration and hernia. In eventration, the diaphragm is abnormally high in level, due to either congenitally aplastic or acquired atrophic muscle fibers. Various writers have designated this condition by different terms, such as relaxation, insufficiency, high position, or dilation.

Hernia of the diaphragm is either congenital or traumatic in origin. Both hernia and eventration are seen much more commonly on the left side. Of various statistical summaries, Eppinger reports 626 left-sided hernias as compared to 8 on the right side. Thomas, in his review, found 8 right



Fig. 3. Roentgenogram taken 24 hours after the barium meal, showing barium-filled colon in chest.

and 282 left. Twenty cases have been reported from the Mayo Clinic, 17 on the left side and 3 on the right.

Of a series of 17 cases reported by Carman and Fineman, one presents a remarkable similarity to the case I have just shown. Their patient was a woman 47 years old, who had suffered vague abdominal distress for years. They reported as follows: "A roentgenogram of the chest revealed gas bubbles above the right diaphragm and an opaque enema showed herniation of the colon through a large opening in the right diaphragm. At operation the transverse colon and omentum were found herniated into the chest. The hernial opening, 8.75 cm. in diameter, was found in the middle line posterior to the attachment of the diaphragm to the sternum. The patient's recovery was uneventful."

LeWald reported a very similar case in which operation showed the colon to enter the thorax behind the liver. In his case a

portion of the duodenum was above the diaphragm.

The type of case with herniation of the large bowel presents an entirely different picture from that of the right diaphragmatic hernia of the short esophageal type. Fineman, in describing a case, remarks that this type strongly simulates the appearance of walled-off fluid in the right lower chest.

The roentgen diagnosis of hernia or eventration of the diaphragm is not difficult if the condition is kept in mind during the routine examination of chest films and gastrointestinal cases. The differentiation between hernia and eventration is not so easy in some cases and may be impossible by the roentgen examination. Pneumoperitoneum may be useful as a differential aid if a barium series does not complete the necessary evidence. When, as was found in the case here reported, the upper zone of the shadow shows gas-containing loops of bowel, an absence of a bow-shaped diaphragmatic shadow, and the condition on the right side, the diagnosis of hernia can be made from chest films.

The literature contains reports of a considerable number of eventrations and hernias which have been explored with an aspirating needle. Truesdale reports one case where an exploratory chest puncture showed milk which the patient had drunk a short time before. The danger of this error is obvious and such errors can be avoided if the possibility of diaphragmatic anomaly is kept in mind.

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Fig. 4. Roentgenogram taken 48 hours after the barium meal.

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# A NEW DIAPHRAGM FOR THE COMPLETE ELIMINATION OF SECONDARY RADIATION

By A. L. SORESI, M.D., Visiting Surgeon, Greenpoint Hospital; Consulting Surgeon, Bushwick Hospital; Visiting Surgeon, Parkway Hospital, BROOKLYN, N. Y.

THE abolition of secondary radiation has been one of the most perplexing problems confronting radiologists. The Bucky-Potter diaphragm, notwithstanding its great merits, solves only a few of the problems concerning elimination of secondary radiation. The limitations of the Bucky-Potter diaphragm are so well

known to roentgenologists that we do not even attempt to mention them.

The writer wishes to present a new diaphragm, the usefulness of which is not limited to any special technic, but which can be used for every purpose in all kinds of radiographic or radiosopic investigation, fulfilling all the desiderata of the radi-

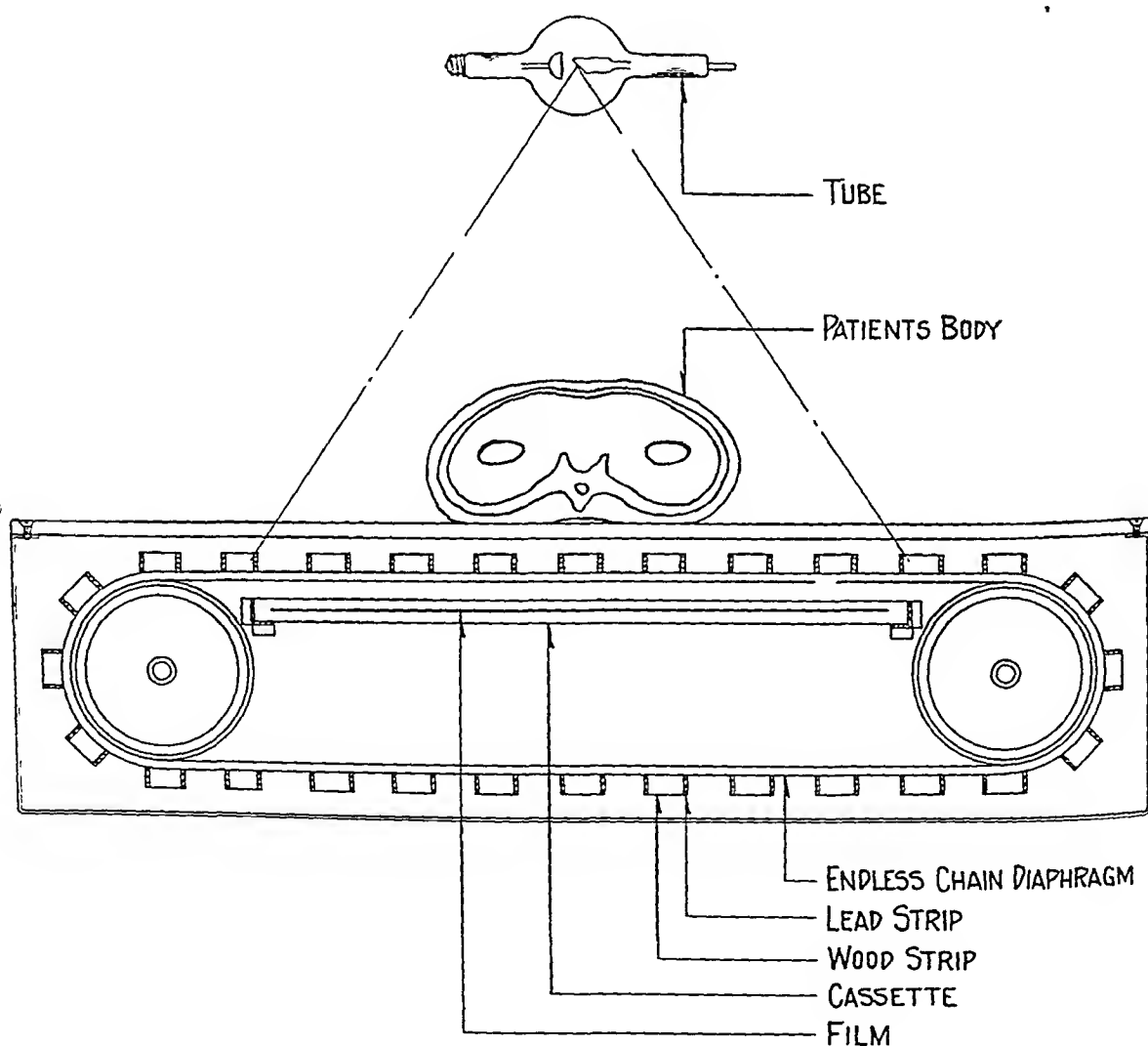


Fig. 1. Drawing of Soresi diaphragm.



Figs 2 and 3. Chest of a heavy man. Both films were taken at 2 meters, one-tenth of a second exposure, with the same cassette. They were developed at the same time. All radiographic factors were exactly alike in these films, except that Figure 2 was taken with the Soresi diaphragm and Figure 3 without a diaphragm.

ologist. The author's diaphragm has the following characteristics:

1. It eliminates effectively secondary radiation.
2. It does not increase the time of exposure.
3. It can be used at any focal distance
4. It allows the taking of radiographs at any speed with a sharpness of detail hitherto unknown.
5. It does not leave grid marks on any part of the film.
6. It is used also for fluoroscopy, making this procedure more useful by clearing considerably the image on the fluorescent screen.
7. It works independently from the X-ray tube.
8. It makes soft tissues very clear and distinct.
9. It works in any position.



Fig. 4. Radiograph of a young woman, 27 years of age, with goiter; normal trachea



Fig. 5. Carcinoma of larynx, extending to trachea. Note infiltration of tissues revealed by the X-rays. Distance, 72 inches; time, one-tenth of a second.

10. It can be used for all kinds of radiographic or fluoroscopic work.

We shall not enter into details of construction, which may vary with further experience and the requirements of manufacturing.

The fundamental principles on which our diaphragm is based are: (1) the lead strips are not parallel to the rays emitted by the tube; (2) the lead strips move at a tremendous speed independently of the X-ray tube; (3) the high speed at which the diaphragm moves is made possible by arranging the lead strips on an endless chain put in motion by a suitable electric motor. Physicists and radiologists may look upon these claims with skepticism. In fact, in discussing the conception of this diaphragm with leading men, nothing but the words "impossible," "contrary to physical principles," *et similia* were heard. However, skepticism was turned to praise, at times



Fig. 6. Chest, at 72 inches; exposure, one-tenth of a second.

even above merits, when the diaphragm was demonstrated in actual radiography and radioscopy.

The writer's diaphragm works with absolute independence of the X-ray tube. It is set in motion, whether for fluoroscopy or radiography, and the current is passed through the tube when and as long as desired independently, and is timed by the usual apparatus.

The *modus operandi* is simplicity itself: films are placed in a channel located behind the diaphragm, which is then set in motion. The exposure is made by pressing the button of the timer, as is done when exposures are made at present without a diaphragm, the timer alone controlling the time of exposure.

#### FOR FLUOROSCOPY

The fluorescent screen is applied against the cover protecting the lead strips, the patient being in front. The diaphragm is set

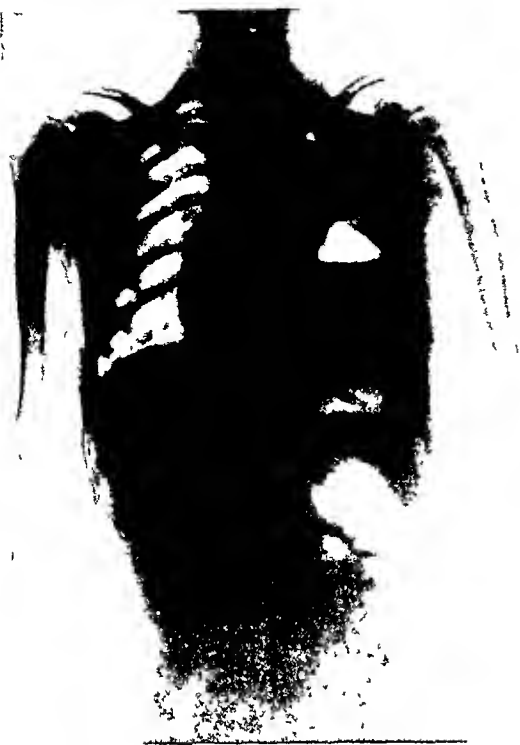


Fig. 7. Chest of a child, 6 years old, with pneumo- and pyo-thorax, at 72 inches; exposure, one-twentieth of a second



Fig. 8. Carcinoma of esophagus in the middle third. Note how the tissues infiltrated by malignant cells stand out clearly. As in all other illustrations, the reproductions must of necessity fail to give the richness of detail shown in the original films. Distance, 72 inches; time, one-tenth of a second.

in motion and the current passed through the tube in the ordinary manner. Observation on the fluorescent screen is made through the double layer of lead strips and is exceedingly clear.

Special apparatus is in process of construction for combined fluoroscopy and radiography.

We have taken films of the digestive organs (stomach, gall bladder, colon, liver, spleen) all on one film, at about forty-five inches in three-tenths of a second, and of the chest, trachea, and esophagus, at seventy-two inches in one-twentieth of a second. Some of the radiographs are reproduced as illustrations in this paper, though it is an understood fact that reproductions fail to give the true impression one receives from the original films. The films taken with this diaphragm have a brightness and a

lively character, lacking in films taken without the diaphragm described. Special mention should be made of soft-tissue revelation. The trachea, the epiglottis, the contour of tumors of the esophagus through the mediastinum, hairs, as well as silk and linen tissues and threads become plainly visible on the film.

We believe that this new diaphragm has a broad field of usefulness. The fact that it does not increase the time of exposure makes possible the elimination of secondary radiation on instantaneous films, thus giving them a most remarkable clearness of detail. The fact that it can be used at any focal distance allows elimination of secondary radiation on films at any focal distance, thus allowing clearer films of the chest at 72 inches or of the dense abdominal organs at 30 inches. The fact that it does not increase

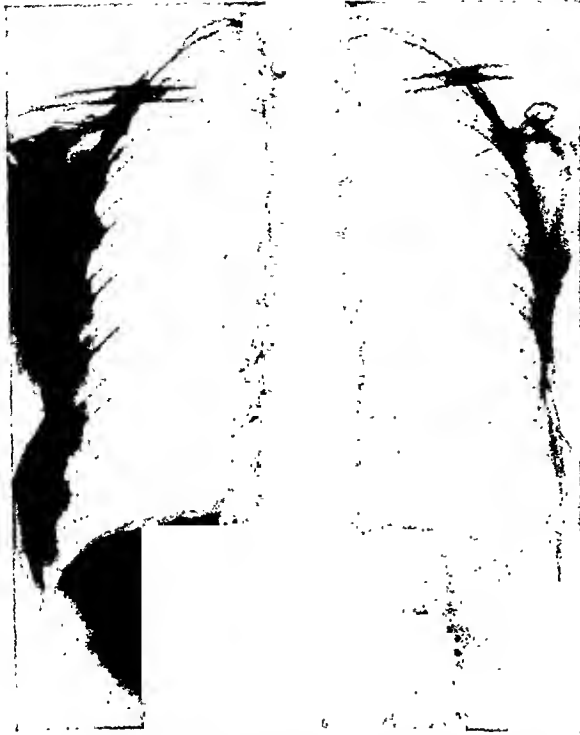


Fig. 9. Same case as shown in Figure 8, anteroposterior view. Note how the growth is shown through the mediastinum. Distance, 72 inches; exposure, one-tenth of a second.



Fig. 10. Skull taken at 72 inches; exposure, one-twentieth of a second.



Fig. 11. Gall bladder and colon taken at 40 inches; exposure, four-tenths of a second. In the original film the spleen, the liver, and the right kidney are plainly visible.



Fig. 12. Same case as shown in Figure 11, with the barium meal in the stomach.

the time of exposure makes radiography and radioscopy safer for patients, attendants, and tubes.

In conclusion, the writer hopes that the rapidly moving diaphragm herein described, with its unique features of abolishing secondary radiation while not increasing the time of exposure; its adaptability to any

focal distance, to any speed, to any position, to both radiography and fluoroscopy, will be of help to radiologists.

The writer wishes to acknowledge the intelligent co-operation of the staff of the Westinghouse X-ray Co., Inc., and especially of Mr. Wappler, Mr. Fayer, and Mr. Larson.

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The Relationship between Radiology and Medicine. Wright Clarkson. Virginia Med. Monthly, August, 1930, LVII, 298.

The value of roentgen diagnosis is so striking that hundreds of physicians are succumbing to the lure of the manufacturers and are buying X-ray equipment without an adequate conception of the science of radiology. No branch of medical science requires more profound and prolonged study to master than that of radiology, because it extends into every phase of medicine, and the radiologist becomes a consultant in every specialty of practice. Most radiologists have no patients of their own but work purely as consultants, and as such should help correlate their findings with the clinical history and other data in actual

consultation with the referring physicians or surgeons.

W. W. WATKINS, M.D.

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Sources of Danger in Superficial Therapy. Dezsö v. Kémeri. Strahlentherapie, 1930, XXXVIII, 187.

The author observed that inaccurate readings of the milliamperemeter are quite common, due to electrostatic changes. The moisture of the room has great influence on this phenomenon. It appears that at a room temperature of from 15 to 20 degrees centigrade, a drop of the hygrometer from 40 to 35 degrees may lead to a difference in the dose up to 120 per cent. This fact should be considered more carefully in medico-legal cases.

ERNST A. POHLE, M.D., Ph.D.



# THE POST-OPERATIVE BEHAVIOR OF THE DIAPHRAGM<sup>1</sup>

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From the X-ray Department of the Presbyterian Hospital, Denver

SIX months ago it was determined to investigate some phases of post-operative chest complications by means of X-ray examination. The practice of making bedside X-ray examinations before and after operation was begun.

To date, the series of cases which have been radiated includes high and low abdominal operations, herniotomies, kidney

dium applied to the cervix uteri, breast amputations, and operations upon the feet.

The anesthetics given to this group included local, spinal, rectal, ethylene, nitrous oxide and oxygen, and ether. Primarily the search was intended to be made for unsuspected atelectasis, and, in spite of the fact that our series of examinations thus far has been accomplished in the late Spring,



Fig 1-A Demonstration of effect of variation of technic in the level of the diaphragmatic domes. Bedside patient. Back flat on cassette. Cf Fig 1-B



Fig. 1-B. Same case as shown in Figure 1-A. Right side purposely rotated forward to a marked degree. Tube-to-plate relationship remains the same. This "error" in technic does not affect the relative height of the domes of the diaphragm.

operations, thyroid operations, perineal repair, curettements, hemorrhoidectomies, one submucous resection, two cases of ra-

Summer, and early Fall months, during which seasons chest complications are at a minimum in Colorado, we have found a considerable number of cases of atelectasis which would have passed unrecognized. The

<sup>1</sup>Read before the Radiological Society of North America at the Sixteenth Annual Meeting, at Los Angeles, Dec 1-5, 1930.

study will continue throughout the Winter and early Spring (17).

Many other interesting types of unus-

pared to their relative shape and position before operation. (See Figs. 8-A, 8-B, 9-A, 9-B, 9-C, 10-A, and 10-B.)

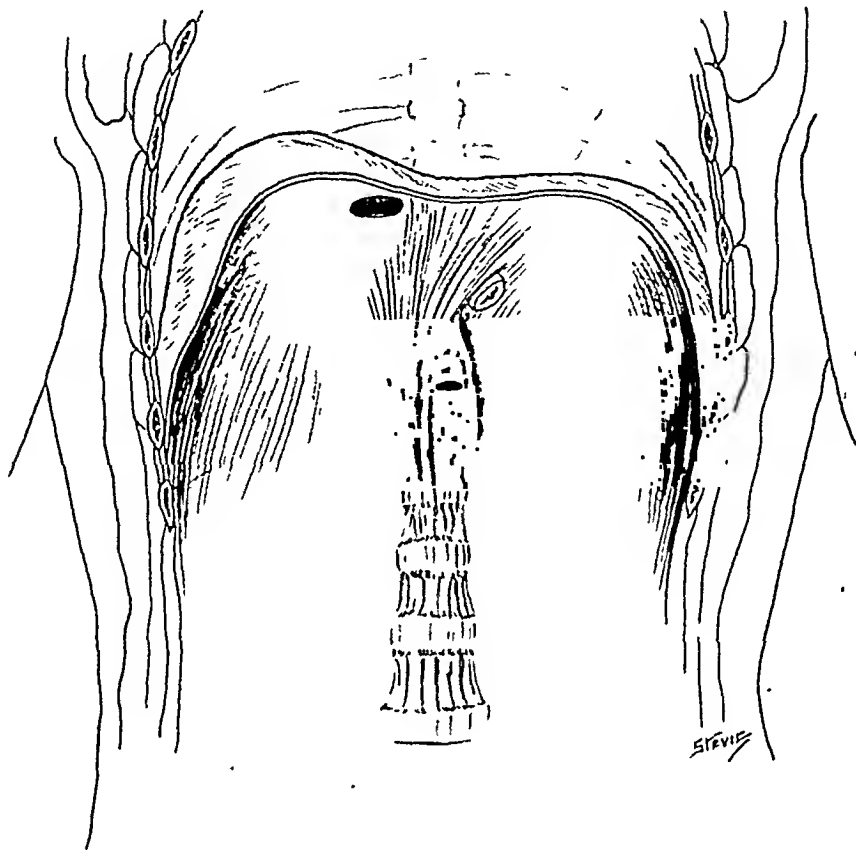


Fig. 2. Under surface and cut anterior edge of the diaphragm. Note how much lower the origin is than the insertion (central tendon in the dome). See text.

pected chronic and acute chest pathology have been revealed in the series. These will be described in another paper.

Early in the study it was noticed that in many instances (54 out of 94 cases) both diaphragm domes maintained a higher position immediately after than before operation. It was not long after this condition had manifested itself that an occasional case presented an asymmetrical relationship between the shape and position of the two hemidiaphragms after operation, when com-

This paper will confine itself essentially to that portion of the study which deals with the post-operative asymmetry of the diaphragmatic domes. A consideration of the relationship of this condition to atelectasis by the writer of this article may be found in a previous paper on the subject of post-operative chest complications (9).

Thirty-six cases out of 94 (the total number studied to date) have shown a sharp arching and high position of the right hemidiaphragm, and five cases have shown a



Fig. 3-A Pre-operative X-ray examination  
Cf. Fig 3-B



Fig. 3-B Two days post-operative examination of same (low abdominal) case as shown in Figure 3-A, made at full inspiration. Both domes are high, with superimposed additional ascent of the right hemidiaphragm. The heart is forced to a horizontal position, extending more to the right of the spine than in the pre-operative plate. Collateral lung clear. See text.

similar situation of the left half of the diaphragm, with no X-ray or clinical evidence of disease of the collateral lung.

The affected hemidiaphragm is found to have assumed a high position when examined the day after operation, and as a rule it gradually subsides to the pre-operative position and shape when visualized at inspiration by the same technic as at the first examination, in a week or ten days. In some instances the affected dome was still high three weeks later. A few have subsided markedly in three or four days.

Many cases show both hemidiaphragms to be high after operation, with one asymmetrically higher than the other. This causes the heart to assume a more horizontal position and thus may cause it to encroach farther on the side of the higher diaphragm than it did in the pre-operative plate. This combination gives a strong impression of atelectasis, and it was at first thought that these findings, in the absence of visualized

density of the lung, were the result of an atelectasis which, perhaps, was obscured behind the dome in the posterior sulcus, but lateral X-ray plates and close clinical observation have disproved that conception. Brunn and Brill (15) illustrate a paper<sup>2</sup> with a typical case of asymmetrically high hemidiaphragm which they attribute to a minor degree of atelectasis, yet the lung field is clear. Our series of cases have led to the belief that this condition may precede and contribute to atelectasis.

After this phenomenon had been repeated in several patients, the recent literature was reviewed and reference found to a symmetrically high position of both diaphragmatic domes following abdominal operations

<sup>2</sup>This article was noted just prior to the final typing of this paper.



Fig. 4-A. Pre-operative plate of a nephropexy case. Cf. Fig. 4-B.



Fig. 4-B. Same case as shown in Figure 4-A, two days post-operative. Not only is the right hemidiaphragm high with no evidence of atelectasis above, but there is marked bilateral ascent of both diaphragms with hypoventilation of both lungs. Note left kidney incision clips and large amount of abdominal gas. See text.

(5, 8) in several smaller series of cases, but attention was not called to a high position of one side only. The nearest approach to a mention of this condition, except as a sign of atelectasis, which I have found was by Sise, Mason, and Bogan (12). They state that ten cases of gall-bladder surgery radiated before and after operation showed a marked diminution of *excursion* in both leaves of the diaphragm, with the greater effect on the right.

We concur with Muller (7) that the bilateral post-operative high position of the diaphragm can possibly be explained without much consideration of hypotonus, paresis, or partial paralysis. The one-sided high position, however, seems to require serious consideration of possible nerve inhibition or paralysis of varying degree.

Most chest complications, especially atelectasis, occur unilaterally, and more on the right side than on the left, and more often in the lower lobe than in the upper. The

high diaphragm finding occurs much more often on the right, and would, of course, have more effect on the lower lobes than on the upper lobes.

Because of these considerations the subject is deemed sufficiently important to warrant the presentation of our observations thus far and the venture of interpretation. It therefore becomes the purpose of this paper to describe and interpret these X-ray manifestations and to allude to the cause, hoping that a little evidence may be added to the rapidly accumulating data on the subject of post-operative chest complications.

#### RADIOGRAPHIC TECHNIC

Because we were studying the difference in the relative position of the two diaphragmatic domes, and not the position of



Fig. 5-A. Pre-operative chest roentgenogram. Cf. Fig. 5-B.



Fig. 5-B. Same case as shown in Figure 5-A. Some asymmetrical ascent of the right hemidiaphragm. Note that air admitted by abdominal operation has sought only the right subdiaphragmatic area. See text. Note also the sharper outline of the high dome as compared with the opposite side and the same dome prior to operation.

either one as measured from a bony landmark, variance in the target-to-plate distance and angle at which the patient was raised made no appreciable difference in the findings. This was demonstrated by making two or more examinations on the same patient, each with different technic. Even when the patient was turned with one side farther from the plate than the other, the diaphragmatic domes were not changed in their relative height (Figs. 1-A and 1-B).

Some of the earlier cases of the series were examined pre-operatively at the erect chest plate changer, followed by post-operative bedside plates. This did not interfere with the results in any case. The majority of the cases, however, were radiated in bed with exactly the same technic before and after operation, the beds being brought to the radiographic room. The central ray was passed through the ensiform at right-angles to the plate, 46-inch distance, 100 milliamperes, one-tenth second, and the kilovoltage

variable. Every effort was made to reproduce after operation the technic employed before. All patients were asked to take as deep a breath as possible and hold it during the exposure.

We hope as we continue our study to make more examinations in the lateral position. They are valuable to other phases of the work but probably will not add much evidence to the problem discussed in this paper.

#### ANATOMY

A glance at Figure 2 to refresh our memory of the anatomy (1) of the diaphragm, reveals that its origin, which is on the lower five or six ribs, upper three or four lumbar vertebrae and ensiform, is lower than the insertion, namely, the central tendon



Fig. 6-A. Pre-operative roentgenogram (exposure too light to penetrate breast shadows and bases). Cf. Fig. 6-B.

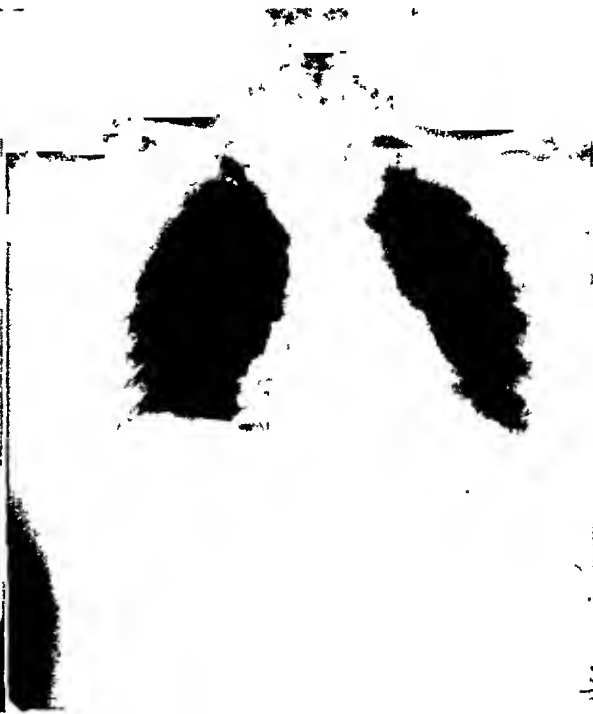


Fig. 6-B. Same case as shown in Figure 6-A, one day post-operative. Note change in relative position of the domes of the diaphragm with no demonstrable right lung disease. Note narrowed interspaces on the right. See text.

which is practically the highest part of each hemidiaphragm. Contraction must cause the arched dome to descend and flatten. Relaxation or paralysis permits ascension and arching. This is demonstrated physiologically by inspiration (contraction) and expiration (relaxation), respectively. This fact is further demonstrated, pathologically, after the operation of phrenico-exeresis.

The diaphragm is merely a thin membrane-like partition fastened loosely across the thoraco-abdominal cavity. Atmospheric pressure on the flaccid-walled abdominal portion of the cavity keeps the thin hemidiaphragms ballooned upward into the rigid-walled thoracic cavity (3). Contraction works against this abdominal pressure and causes flattening and descent of the domes: relaxation permits them to passively ascend and arch.

#### DISCUSSION

It is logical to believe that the more con-

stant post-operative findings of bilateral high position of both hemidiaphragms and the less common phenomenon of one dome arching to a higher position after operation than its position relative to the opposite dome before operation, are not existent from the same causes.

Two main causes of the bilateral symmetrically raised diaphragm present themselves. The first to be thought of is that pain occasioned by deep breathing will prevent the patient from inspiring as fully after operation as before. The other most tenable cause is an increase of intra-abdominal pressure, caused by accumulating gas, which forces both domes upward. (See Figs. 3-A and 3-B.)

Abdominal and many other major operations are attended with post-operative pain when the patient inspires deeply (6). This prevents him from taking as deep a breath when radiated after operation as at



Fig. 7-A. Pre-operative X-ray examination. Right hemidiaphragm normally a little above the left one. Cf. Figs. 7-B and 7-C.



Fig. 7-B. Same case as shown in Figure 7-A, two days post-operative. Note that the domes are now of equal height, probably indicating asymmetrical ascent of the left hemidiaphragm. Cf. Fig. 7-C.

his X-ray examination prior to operation. Table I exhibits statistics which strengthen this opinion. It will be noted that abdominal

operations, kidney operations, perineal repair, and thyroidectomies show the highest incidence of bilateral raising of the dia-

TABLE I

OCCURRENCE OF ASYMMETRICAL HIGH HEMIDIAPHRAGM NOTING ALSO NUMBER OF BILATERAL CASES

| Type of operation   | No. of cases | Unilateral high diaphragm |            | No. of cases of bilateral ascent of diaphragm |
|---------------------|--------------|---------------------------|------------|---|
|                     |              | No. of cases              | Percentage |   |
| Herniotomy          | 4            | 3 (all right)             | 75%        | 2   |
| High abdominal      | 13           | 9 (8 right; 1 left)       | 61%        | 8   |
| Kidney              | 10           | 6 (5 right; 1 left)       | 60%        | 7   |
| Low abdominal       | 34           | 12 (11 right; 1 left)     | 47%        | 16  |
| Uterine curettage   | 5            | 2 (1 right; 1 left)       | 40%        | 0   |
| Hemorrhoid          | 3            | 1 (right)                 | 33%        | 0   |
| Thyroid             | 15           | 3 (2 right; 1 left)       | 20%        | 7   |
| Breast (amputation) | 3            | 0                         | 0%         | 0   |
| Perineal            | 2            | 0                         | 0%         | 2   |
| Foot operations     | 3            | 0                         | 0%         | 1   |
| Radium to cervix    | 2            | 0                         | 0%         | 0   |
| Submucous resection | 1            | 0                         | 0%         | 0   |

phragm following operation. These types of operative procedures cause the most post-operative pain upon deep breathing.

Patey (6), Head (8), and Oberholt (16)<sup>3</sup> measured the vital capacity (the total volume of air obtained from a maximum expiration following a maximum inspiration) before and after abdominal and other operations. Following operation there was a smaller vital capacity than before. The abdominal operations caused the greatest discrepancy.

Evidence upholding the abdominal gas factor as a cause was found in a study of serial X-ray examinations of new born infants<sup>4</sup> beginning immediately at birth with plates, made at varying intervals up to ten days, on file with the Child Research Council of the University of Colorado Medical School. It was noted that as air was ingested first into the stomach and then into the small and large intestine, the hemidiaphragms gradually ascended in relation to the increase in the amount of air and fermentative gas. Unilateral disposition of the gas caused symmetrical upward displacement of both sides of the diaphragm. In none of the cases reviewed was there an asymmetrical upward displacement of the diaphragm. Further evidence supporting abdominal gas as a cause of bilateral symmetrical raising of the diaphragm is furnished by some adult cases in our present series, which show one-sided accumulation of gas (Figs. 3-A and 3-B) accompanied by a symmetrically high diaphragm.

Pressure in the abdomen apparently follows the law of pressure on liquids, namely, that it is exerted equally in all directions. This is graphically demonstrated in the paradoxical movement with respiration of a phrenicectomized hemidiaphragm. Pressure downward on the abdominal contents by the



Fig. 7-C. Same case as shown in Figures 7-A and 7-B, fifteen days post-operative. Right hemidiaphragm again higher than left, as in the pre-operative plate. Left dome has subsided.

normal side is transmitted as though by a liquid medium to the passive side.

Muscle splinting in abdominal cases may exaggerate the pressure caused by the increasing gas.

The presence of bilateral paralysis as a cause is obviated by the lack of symptoms. Whereas paralysis of one hemidiaphragm may have very slight symptomatology because, as Andrus and Wilson (11) tell us, there is reduction of only one-sixth to one-third of tidal air rate and respiratory volume, which is quickly compensated for by the other lung, bilateral paralysis, on the other hand, reduces tidal air volume by 60 per cent and respiratory volume by 62 per cent. The bilateral high diaphragm was found in too many cases of uneventful and symptomless recovery to permit of suspecting paralysis as a cause even in degrees less than complete.

The statistics of our series further indicate that the causes of unilateral rise are

<sup>3</sup>Published after this paper had been typed.

<sup>4</sup>The writer wishes to thank Dr. W. W. Wasson for the suggestion that he review these cases.



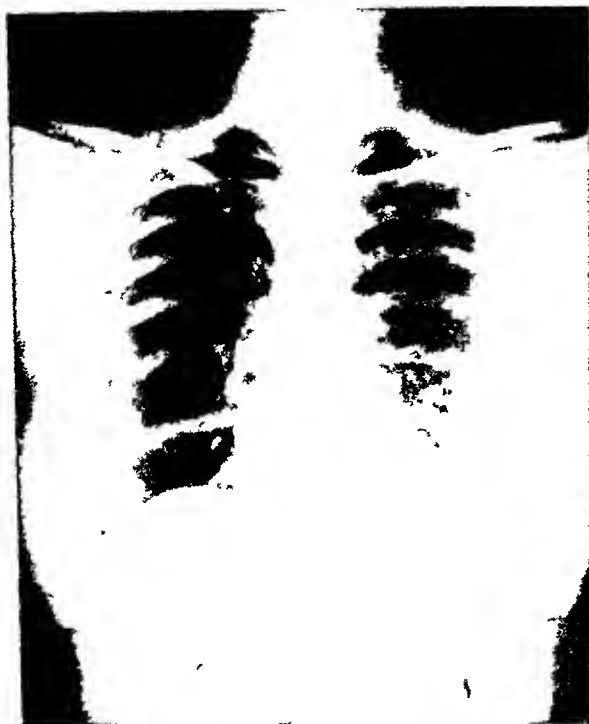


Fig 8-A. Pre-operative plate Cf Fig 8-B



Fig 8-B Same case as shown in Figure 8-A, one day post-operative. No density indicating atelectasis of sufficient extent to require this much diaphragmatic ascent. No clinical indication of lung pathology.

different from those of bilateral high position. There were at least eight of the former not accompanied by the latter condition and at least ten of the latter type of cases not accompanied by asymmetrical high diaphragm.

Explanation of the high position, following operation, of *one* diaphragmatic dome is not so manifest. Thus far we have been unable to evolve an explanation without resorting to the idea of at least a partial paralysis.

After studying the ninety-four cases in this group there can be no doubt but that in a certain number of operative cases one dome of the diaphragm assumes an abnormally high position *in relation to the opposite dome*, without X-ray or clinical evidence of collateral lung disease.

Each case has been carefully measured to establish the relative position of the two domes. Unless a change of 1 cm. or more was present, the case was not included in

the statistics. In many cases of one-sided post-operative rise, the opposite dome had also mounted after operation by virtue of the causes of bilateral post-operative rise, so that most of the measurements of one-sided ascent of from 1 cm. to 4.5 cm. are in excess of the bilateral ascent, which apparently varied from 1 to 4 centimeters. (See Figs 4-A and 4-B.) (Error in measurement of the ascent of both diaphragms in relation to the spine or other bony landmark could be caused by variation of technic; therefore, the figures of these measurements are not presented.)

Asymmetrical action of the diaphragm precludes all possibility of voluntary restriction, and the cause will probably be most fruitfully searched for in the realm of the pathological. So far, we have no experimental data to help us determine the fundamental etiology of this condition and we

must be content at this time to present our observations and advance a discussion of the cause from the basis of clinical reasoning. From the evidence thus far accumulated, interference of the motor nerve impulses to the affected hemidiaphragm is the most tenable etiological theory of this phenomenon which takes place in the short interval between the day previous to operation and the day after.

Anatomical muscular weakness has been suggested. Anatomical defects are more common on the left. The "high diaphragm" of this series is predominantly on the right side. Furthermore, it is hard to believe that 43 per cent of individuals have such a degree of one-sided muscular weakness, which is symptomless and not evident by X-ray examination before operation, that it would permit upward displacement of a hemidiaphragm to the extent seen in our series. Autopsies show no gross organic evidence of such a high percentage of malformation.

Engorgement of the liver would cause bilateral diaphragmatic rise because of its mobility. It moves up and down readily with respiration by virtue of the contractions of the diaphragm, and, therefore, a properly functioning right dome would exert sufficient restraint to an enlarged liver to cause it to press down into the abdominal contents, and thus, increasing intra-abdominal pressure, exert equal upward force on both sides of the diaphragm.

The X-ray plates themselves, as has been stated, rule out lung pathology as a cause of this condition. Those cases which exhibited sufficient atelectasis to require diaphragmatic upward displacement to compensate for the absorbed air have been excluded from this series.

Further evidence favoring interference with the motor nerve supply as the most important underlying factor, is presented by the fact that a considerable number of the

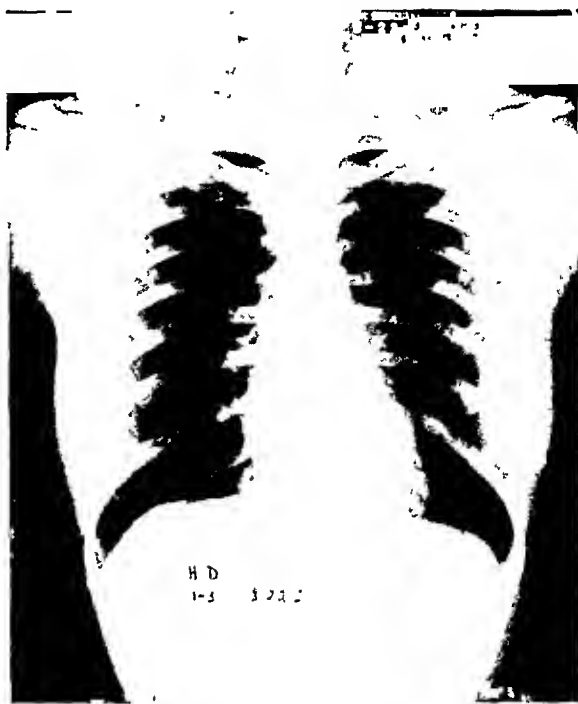


Fig. 9-A. Pre-operative X-ray examination. Cf. Figs. 9-B and 9-C.

high diaphragms show a higher arching with a sharper outline than the active opposite side and the same dome prior to operation (Figs. 5-A and 5-B). Radiographs of the diaphragm of normal persons show a sharper outline at expiration than inspiration because they are caught during the period of relaxation, a condition which is also made evident in plates following one-sided phrenicectomy. At inspiration a normal diaphragm tends to flatten, and, even though the patient does not breathe, there is often sufficient quivering of the contracted muscle to show a blurring of outline. This is demonstrated in longer exposures better than in those made in one-twentieth of a second. Comparison of the high and low halves in this series shows, in many cases, a blurring of the low dome and sharpness of the high one, presumably due to tonicity of the one and atonicity of the other. The high side undeniably approaches the shape, position, and sharpness of phrenicectomized hemidiaphragms, differing only in degree. This



Fig. 9-B. Same case as shown in Figure 9-A, post-operative. Note the high right hemidiaphragm with clear lung above. Cf Figs 9-A and 9-C.

will be revealed by a study of the figures illustrating this article. Furthermore, in a few cases of high diaphragm, which we have radiated at inspiration and expiration, the unaffected dome travels farther than the affected one to a sufficiently greater extent than the average normal difference in the excursion of the two, to suggest the paradoxical action so characteristic of phrenicectomy.

The series of ten cases roentgenographed before and after gall-bladder operations of Sise and co-workers (12), previously mentioned, also exhibited inhibited excursion of the right hemidiaphragm in relation to the left half. Because neither half exhibits normal excursion following operation, the effect is not so dramatic as that following excision of a few centimeters of the phrenic nerve.

Observation of this series of cases reveals many instances of hypo-elevation of the ribs and lessening of the interspaces on the af-

fected side (Figs. 6-A and 6-B). They should show an increased excursion and widened interspaces on inspiration in the presence of a hypofunctioning diaphragm (10). This is because: (1) the diaphragm no longer peels from the chest wall in the lateral sulcus region; (2) less intrapleural negative pressure exists, and (3) there is increased inspiration effort to compensate for the hypofunction of the hemidiaphragm. The cases of hemithoracic narrowing and rib depression show no X-ray evidence to the effect that there has been any blockage of pulmonary access to external atmospheric pressure, which situation is immediately manifested on the X-ray plate by marked densities (9), in which condition atmospheric pressure on the external chest wall causes depression of the entire hemithorax by virtue of the fact that the same pressure is removed from the inside.

We can, therefore, logically proffer the question of accessory respiratory muscle enervation. The proposition that the diaphragmatic disturbance is the result of motor nerve impulse inhibition is enhanced by the possibility of a similar condition affecting accessory inspiratory muscles, and *vice versa*.

#### POSSIBLE CAUSES OF POST-OPERATIVE PARALYSIS OF ONE HEMIDIAPHRAGM

If temporary partial paralysis is the correct explanation of the observations described thus far, it is appropriate here to enumerate and briefly discuss some of the most tenable theories of etiology. None of the possible causes to be presented are irrefragable.

*Morphine.*—The administration of morphine does not appear to be responsible for the unilateral rise of the diaphragm. There is some evidence to suggest that it may increase the number of cases of bilateral high diaphragm and thus contribute to hypoventilation. A summary of the amount of mor-

TABLE II

RELATION OF AMOUNT OF MORPHINE ADMINISTERED BETWEEN OPERATION AND POST-OPERATIVE X-RAY EXAMINATION TO BILATERAL AND UNILATERAL HIGH DIAPHRAGM

| Position of diaphragm    | No. of cases | Average total amount of morphine given each patient |
|--------------------------|--------------|---|
| High unilateral position | 33           | 59 mgm.   |
| High bilateral position  | 49           | 60 mgm.   |
| Diaphragms not affected  | 27           | 41 mgm.   |

TABLE III

OCCURRENCE OF HIGH HEMI-DIAPHRAGM IN RELATION TO ANESTHETICS

| Anesthetic                           | No. of cases | Case of high hemidiaphragm |            |
|--------------------------------------|--------------|----------------------------|------------|
|                                      |              | No. of cases               | Percentage |
| Ether                                | 20           | 8                          | 40%        |
| Spinal, Rectal, and Local            | 9            | 3                          | 33%        |
| Gas (NO+O <sub>2</sub> and Ethylene) | 66           | 21                         | 32%        |

phine administered between the time of operation and the post-operative X-ray examination reveals that forty-nine cases in which, after operation, both diaphragms failed to travel through the distance of the pre-operative inspiratory excursion, averaged 60 milligrams. (Table II). The average total dosage of twenty-seven cases in which neither diaphragm was affected was 41 milligrams. The appraisal of the value of this relationship must be made with the realization that the operative cases to which the smaller doses were given had the less extensive operations, and the causes of bilateral rise are present in a less severe degree. The average dose given to thirty-three cases of asymmetrical high diaphragm was 59 milligrams. This is practically the same amount as that administered to the bilateral series.

There was no series of cases which had no morphine, to compare with the series

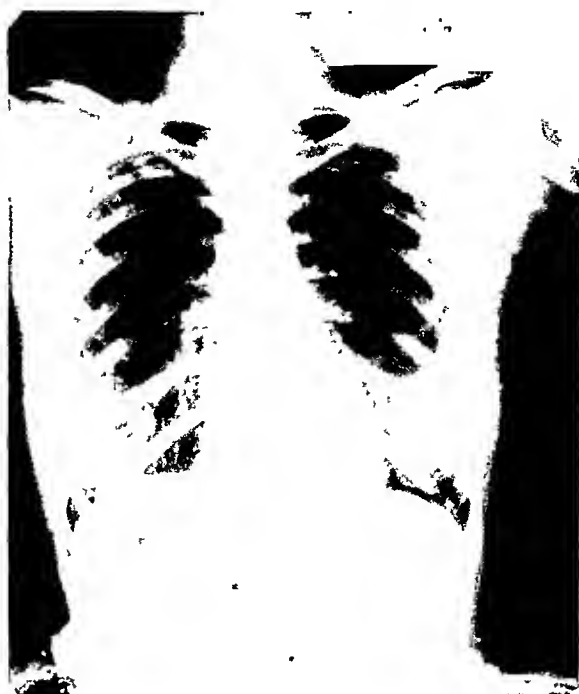


Fig. 9-C. Same case as shown in Figures 9-A and 9-B, three days after the latter. Diaphragm with domes again in normal relation.

which received morphine, and therefore we believe that the only conclusion which is suggested, in addition to the one mentioned, is that asymmetrical high diaphragm differs from bilateral high diaphragm due to other causes than the administration of morphine.

*Anesthetics.*—There was a total of sixty-six gas anesthetics and twenty-one (or about 33 per cent) in this series showed high asymmetrical diaphragms (Table III).

Twenty of the series were given ether. Of this number, eight (or about 40 per cent) had an asymmetrically high diaphragm.

The total number of rectal, local, and spinal anesthetics numbered nine. Three of this number (or 33 per cent) had a high hemidiaphragm.

The series thus far, therefore, indicates that the type of anesthesia has little to do with the incidence of this condition. The slightly higher percentage of ether cases hardly warrants serious consideration.

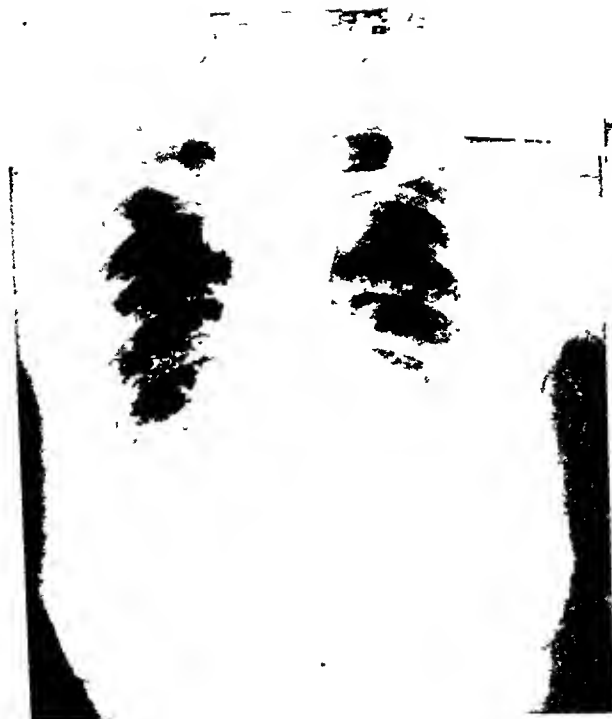


Fig. 10-A. Pre-operative chest roentgenogram of thyroidectomy case. Exposure insufficient to penetrate breast shadows and bases. Cf. Fig. 10-B.



Fig. 10-B. Same case as shown in Figure 10-A, post-operative. High hemidiaphragm. Lung above clear. (Apparent mediastinal shift probably due to rotation of patient.) A little perihilar atelectasis cannot be entirely excluded. The density at the right apex is due to removal of substernal goiter. There is not sufficient atelectasis in any event to require so great an ascent of the diaphragm.

*Type of Operation.*—Table I indicates that there were sixteen cases of high hemidiaphragm out of a total of thirty-four low abdominal operations, and eight cases out of thirteen high abdominal operations. This shows a ratio of 47 per cent to 61 per cent, a difference which can hardly be ignored. Abdominal cases as a whole show 54 per cent to be affected by asymmetrical high diaphragm. A high incision in the abdomen apparently is more effective in producing this condition than the low incision.

Ten kidney operations, with flank incisions, showed six cases (or 60 per cent), closely approximating the high abdominal percentage. Four herniotomies showed three high diaphragms—a percentage of 75. The small number of these cases, however, precludes a definite opinion of the correct percentage. All three cases showed high *right* diaphragms. One had a midline incision (umbilical hernia). and

the other two left-sided incisions (left inguinal). These cases, combined with two high left diaphragms (one of which is shown in Figures 7-A, 7-B, and 7-C), which occurred with right-sided incisions, and with numerous cases of midline incisions followed by right high diaphragm, strongly indicate that the position of the incision in relation to the right or left side in abdominal cases does not decide which half of the diaphragm will be affected.

All other operations, a list of which is shown in Table I, numbered thirty-four. Of this group, only six (17 per cent) had asymmetrically high diaphragm, indicating a much lower percentage than did abdominal, kidney, and herniotomy cases.

It is logical to conclude, therefore, that the type of operation has more effect than

either the type of anesthetic or the administration of morphine.

#### ENUMERATION OF OTHER POSSIBLE CAUSES

Thoughtful consideration of the possible causes of the phenomenon which is the subject of this paper points to the probability of a multiple etiology. When satisfactory explanation of intraperitoneal cases is evolved, the fact that the condition occurs in such cases as curettement and thyroidec-tomies confronts us. That the right diaphragm is affected so much more than the left, should be used as a fact to help determine the cause. Except for one suggestion, mentioned later, no likely single etiological factor for all cases has occurred to us, so we will be content to state different possible causes for different types of operation.

It has long been known that peritoneal cavity lymphatic drainage is much more active to the right hemidiaphragm than to the left (13), due to liver friction and undoubtedly to other causes. That the right subdiaphragmatic area is more easily reached from the intraperitoneal cavity is further suggested by an observation in our series; in all cases which showed residual air admitted through the incision, it was found under the right hemidiaphragm (Fig. 5-B). From the diaphragm the lymphatics drain upward by diagonal trunks to the sternum and anterior mediastinum along the *phrenic nerve* to the hilum region of the lung,—a few vessels go directly to the thoracic duct.

The abdominal cases of high hemidiaphragm, then, could be thought of as being caused by the effect of toxic traumatized protein carried to the right hemidiaphragm, and occasionally the left, where it is held, by disturbed absorption, in apposition to the phrenic nerve terminations, interfering with their conduction. Then after the toxins are finally absorbed they may produce an inflammatory reaction along the course of the

phrenic nerve and perhaps even in the mediastinal lymph-node area. A "vicious circle" situation presents itself on the under surface of the diaphragm. We know that phrenicectomy retards absorption; thus after the first interference of conduction through the phrenic terminations which are spread out on the under side of the muscle, absorption is retarded and more time given for still further inhibitory effect on the nerve terminations.

Reflex effect on the phrenic nerve from impulses carried through the vagus warrants mention here.

If interference of function of the gastrointestinal tract, not only by direct trauma but reflexly by the effect of the anesthetic and shock, causes a toxic material in the abdominal cavity to be liberated into the lymphatics and thence to the diaphragm, a possible cause of all cases is suggested. The smaller the operation and the more distant from the abdomen, the less the gastro-intestinal effect. The evidence of the cases listed in Table I strengthens this opinion.

We know that inflammation of the pleura above the diaphragm is often given as a cause for palsy of this organ and doubtless is the reason for its high arching in certain types of supradiaphragmatic disease. It is difficult, however, to conceive of a reason for a pleural inflammatory process in many of the types of surgical cases which have been followed by high hemidiaphragm, and it could hardly become effective in the short time between operation and post-operative X-ray examination.

General shock, with resulting phrenic nerve inhibition of cerebral origin, or the same result from cortical toxemia or lowered blood chlorides from intestinal stasis, must be included in our list of possible causes. This, however, suggests the question as to why the result should be unilateral. Some of our cases, of course, may have bilateral inhibition, which, because of the normal ex-

cess of excursion of the right hemidiaphragm, is manifested more on the right than on the left side, and therefore is not recognized as occurring on both sides.

Another consideration worthy of inclusion in this list is possible pressure on the phrenic nerve along its intrathoracic course. We know that long-continued pressure, such as that caused by effusions, empyema, tumors, and inflammatory processes of the mediastinum, may bring about phrenic nerve paralysis (14). Engorgement of the superior vena cava may also increase the mediastinal pressure on the phrenic nerve. The lessened abdominal pumping, because of the bilateral failure of the diaphragm to function fully after operation, upon the abdominal inferior vena cava might lend to this condition.

It is conceivable that cardiac dilatation could cause stretching of or pressure upon the pericardial portion of that nerve.

#### RELATIONSHIP TO POST-OPERATIVE CHEST COMPLICATIONS

Whether high hemidiaphragm is the result of paralysis or not, and regardless of the cause of the problematical paralysis, the fact that a certain percentage of cases presents a high clear-cut arch of one dome only, without demonstrable collateral lung disease, has a certain significance in the interpretation of bedside post-operative X-ray examinations of the chest.

Knowledge that this condition exists warns one against interpreting a high dome plus hypoventilation as sufficient evidence upon which to base an opinion of massive atelectasis. It is probable that many of us who make post-operative X-ray studies of the chest have more than once rendered an opinion of atelectasis in the presence of this combination of X-ray signs, and wondered at the time how atelectasis of sufficient degree to cause these marked signs could exist

without exhibiting more density, and why the mediastinum did not do its share of the compensation. Perhaps reports in the literature (2) which refer to restriction of a hemidiaphragm as an early sign of atelectasis are based on this condition. It is probably more nearly correct to look upon it as a contributing causal factor rather than a resultant sign.

A paralytic hemidiaphragm may be the explanation of a demonstration in massive atelectasis cases which has been puzzling some of us for a long time. Thus, one of two cases of massive atelectasis of apparently equal areas of lung involvement will show high ascent of the collateral diaphragm and a small amount of mediastinal shifting, while the other case will show short diaphragmatic ascent and a wide mediastinal shift toward the affected lung. Is it not possible that inhibition of the diaphragm in one case and good tonicity in the other might account for this phenomenon? The repeated occurrence of this variation in the replacement action of the diaphragm and mediastinum in previously healthy chests in which there are no adhesions of mediastinum or pleura, strengthens the evidence that inhibition is a cause of the unilateral high position of the diaphragm as a condition preceding atelectasis. High, poorly functioning hemidiaphragm is a likely contributing cause to post-operative atelectasis, for it cannot be denied that a lung deprived of its more important muscle of respiration will have more difficulty in maintaining freely open passage away from the lung field to the outside atmosphere.

#### SUMMARY

1. Forty-three per cent of ninety-four surgical cases subjected to pre- and post-operative chest X-ray examinations have shown a unilateral high position of one hemidiaphragm. The immediate cause of

this observation is undetermined, but may be due to paralysis.

2. Fifty-seven per cent exhibited bilateral high position of the domes. The causes are more obvious and apparently do not include paralysis.

3. Both phenomena, but especially the unilateral high diaphragm, deserve attention in the study of the diagnosis and treatment of post-operative chest complications and in interpretation of post-operative X-ray examinations. Cases exhibiting both conditions at once cause the heart to assume a horizontal position suggesting displacement to one side or the other, and this, combined with a high position of one dome of the diaphragm, may give an erroneous impression that atelectasis is present.

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screen. But so far as we have been able to discover there has been no attempt to use  $\gamma$ -rays for the inspection of opaque bodies except that reported from Russia.<sup>3</sup> According to the meager information available it

characteristics of  $\gamma$ -rays. Since the source of  $\gamma$ -rays used was radium emanation, the most suitable source, these notes will be restricted to  $\gamma$ -rays as obtained from radium emanation.

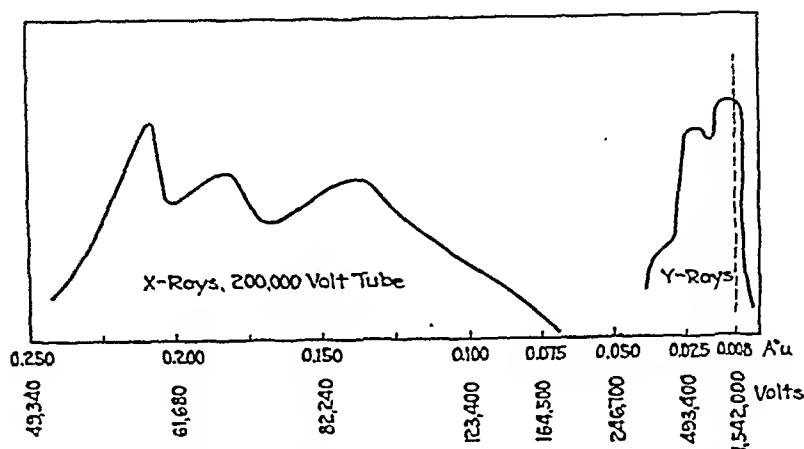


Fig. 2. Curves showing intensities at various wave lengths for X-rays (Terrill and Pine) and for  $\gamma$ -rays (Skobelzyn). The dotted line represents the mean value for  $\gamma$ -rays. (Given by Ellis and Wooster.)

was found possible to locate flaws in steel castings, detecting the emergent beam by an electroscope or a galvanometer and recording the intensity of the beam automatically. No details of this work have ever been made public, so far as the present authors are aware.

It may be said, therefore, that but little has been done on the use of  $\gamma$ -rays for radiography. The present investigation is an attempt, in a preliminary way, to evaluate the use of  $\gamma$ -rays for the detection and location of defects in metallurgical materials.<sup>4</sup>

#### THE PHYSICS OF $\gamma$ -RAYS

In order that the ensuing account may be made clear it is thought advisable to comment briefly upon certain of the physical

Possibly the most noteworthy fact about the radio-active elements is that they transform or decompose to chemically and physically different elements. These transformations are accompanied by radiation, of which there are three types, the  $\alpha$ -rays, which are known to be helium atoms with a double positive charge,  $\beta$ -rays, which are electrons, and  $\gamma$ -rays, which are light waves of very short wave length. The first product in the decomposition of radium is radium emanation, or radon. It is a chemically inert gas,

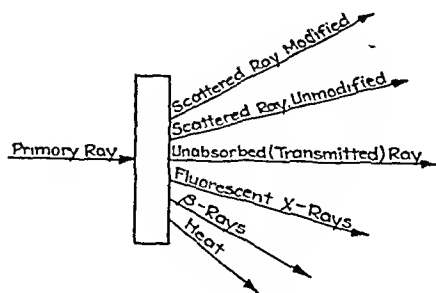


Fig. 3. Changes suffered by radiation in penetrating matter.

<sup>3</sup>As published by Science News Service, No. 361E, Sheet 1, Feb. 24, 1928. It has been impossible to obtain by correspondence information additional to that appearing in the Science News Service report.

<sup>4</sup>The experiments described in the following were performed during the Summer of 1929.

over a hundred times heavier than hydrogen. This gas, radon, in turn decomposes and forms successively Radium A, Radium B,

this, it may be seen that a given quantity of radium produces a constant quantity of radium emanation each second, which, in

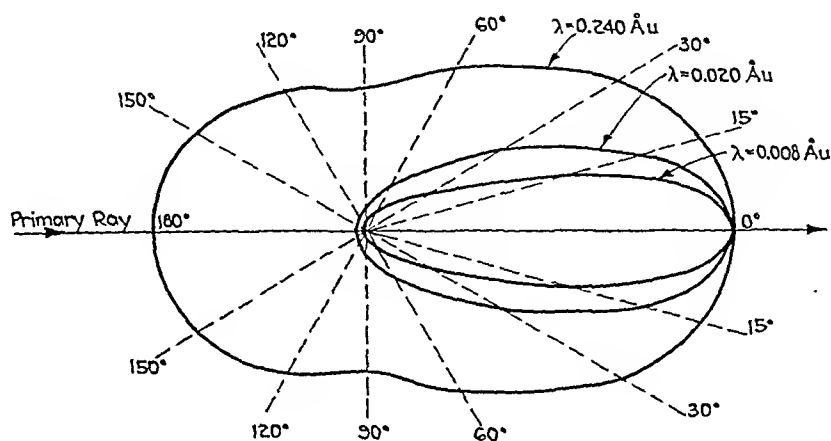


Fig. 4. Distribution of intensity of modified rays scattered at various angles, with primary rays of wave length 0.240 Å.U. (X-rays), 0.020, and 0.008 Å.U. (γ-rays).

Radium C, Radium D, etc., with the final product lead.

Each of these radio-active elements is characterized by a certain rate of decomposition. If the amount present be evaluated (in the usual way) by the strength of the radiation emitted, the rate of decay may be given as

$$\frac{I}{I_0} = e^{-\lambda t}$$

where  $I$  is the intensity measured after time  $t$ ,  $I_0$  the original intensity, and  $\lambda$  is the fraction of atoms present which transforms in time  $t$ . This is a general law for all radio-active substances. Accordingly, the strength of all radio-active substances decreases logarithmically with time (Fig. 1). Since it is impossible to speak of the life of the emanation (for it is infinite), it is customary to speak of the half-life period, that is, the period in which the radio-active strength decreases to half its original value.

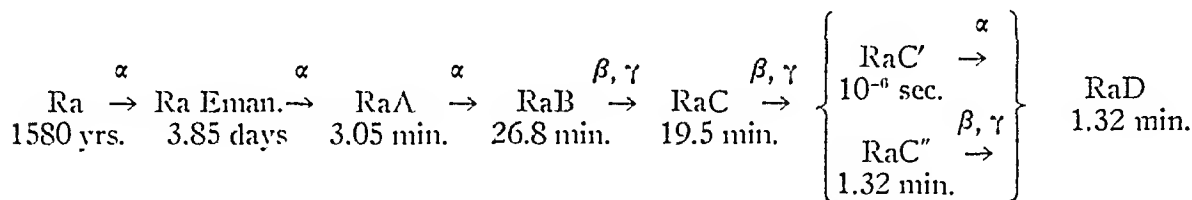
The half-life of radium is about 1600 years. It may, therefore, over a short period be considered as unchanging. Granted

turn, decomposes to Radium A, and so on. With a constant rate of production of radium emanation the amount of radium emanation will build up until the rate of decay of the emanation exactly balances the rate of its formation. At this point the radium and its emanation are said to be in equilibrium.

The transformation of radium to radium emanation is accompanied only by an emission of  $\alpha$ -rays. So far as  $\gamma$ -rays are concerned, the radio-active properties of radium in equilibrium with its products are, therefore, possessed completely by the radium emanation, and for practical purposes it is better to use the emanation.

In medical practice radium emanation is pumped from the parent radium salt (usually in solution) and condensed from the gases with which it is mixed by liquid air. Each gram of radium in the equilibrium state furnishes 0.6 cubic millimeter of gas. This condensed gas is pumped into small glass capsules ordinarily held in small brass containers. The chief source of  $\gamma$ -rays seems to be Radium C, into which radium emana-

tion decomposes. This series of transformations, with the radiations which accompany them and with the half-life periods, is indicated by the following:<sup>5</sup>



As freshly pumped off the emanation reaches its maximum radiating intensity within a few hours, the time necessary for the production of the maximum amount of RaC. Thereafter the strength decreases logarithmically, according to Figure 1, the half-life period being 3.9 days.

The strength of the emanation is measured in millicuries, a millicurie being the strength of 1 milligram of radium in equilibrium with its products as measured by an electroscope receiving the  $\gamma$ -rays only. In medical practice it is customary to pump off the emanation each day. With this procedure, one gram of radium will furnish 160 millicuries of the emanation daily, of which

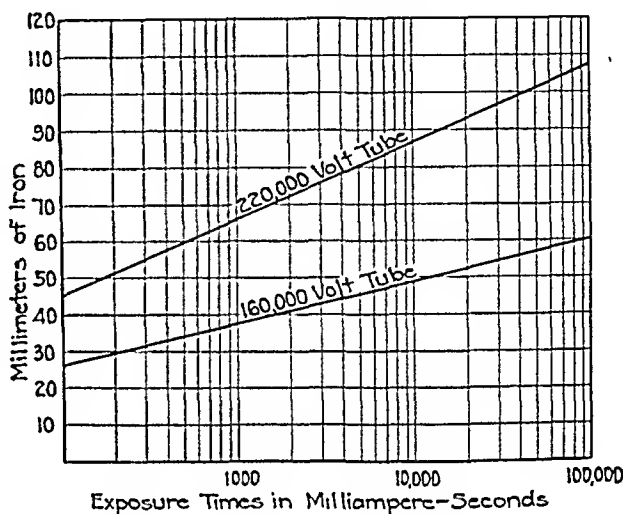


Fig. 5. Exposure curves for X-rays; for a distance of 16 inches from source and with the use of two intensifying screens.

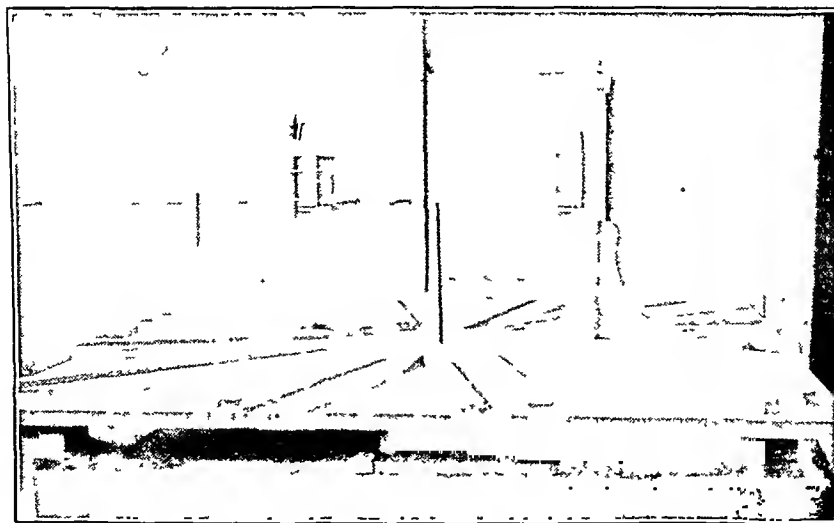


Fig. 6. Table used in  $\gamma$ -ray radiography. Funnel holding radium emanation shown in center.

<sup>5</sup>See, for example, A. Sommerfeld: Atomic Structure and Spectral Lines, Methuen & Co., Ltd., London, 1923, p. 47.

strength between 800 and 900 millicuries available for radiographic purposes.

*Wave Length of  $\gamma$ -rays.*—Approxima-

The relative intensities found by Skobelzyn for the various wave lengths in the  $\gamma$ -ray spectrum are shown in Figure 2.<sup>8</sup>

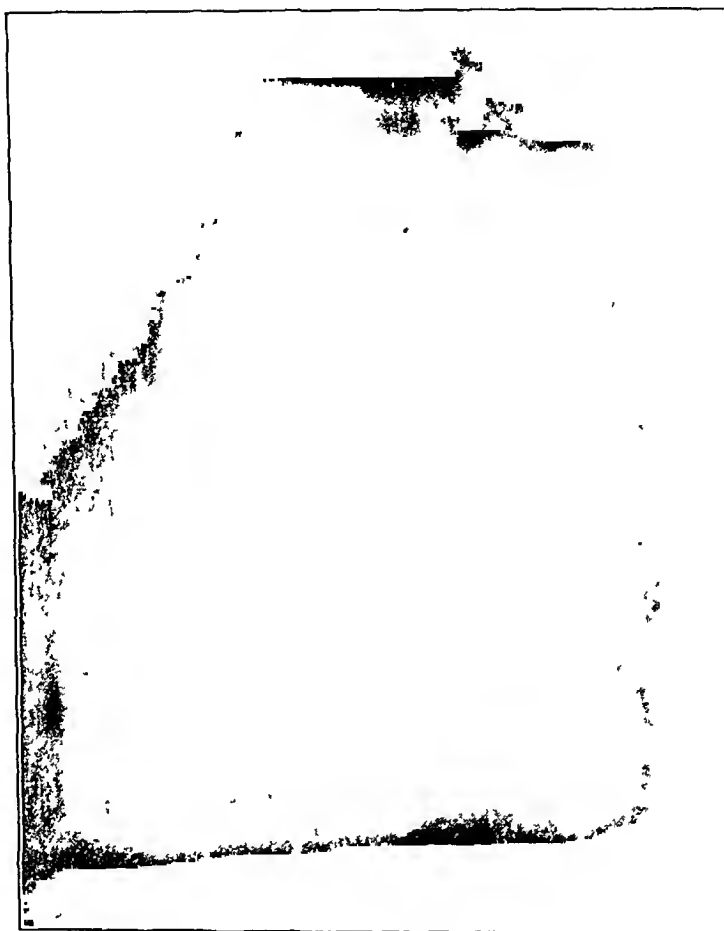


Fig. 7. An echelon of steel plates, as illustrated in Figure 8 (Film No. 1). Distance, source to film, 6 in.; intensifying screen, none; time of exposure, 25 min.; mean strength of emanation, 179 millicuries in one bulb *Results:* Considerable detail on original negative lost in this illustration. Original exposure just sufficient to bring out all details, though enhancing screens would have decreased the exposure time. The spreading on the film was caused, of course, by the closeness of the object to the source.

tions have been made indicating<sup>6</sup> that the  $\gamma$ -ray spectrum lies somewhere in the range 4.100 to 0.005 Å.U. The distribution of intensity in the  $\gamma$ -ray spectrum has recently been studied by a number of workers.<sup>7</sup>

<sup>6</sup>Meyer and Schweidler. *Radioaktivitat*, Teubener, Berlin, 1927, p. 148.

<sup>7</sup>D. Skobelzyn, *Ztschr. f. Phys.*, 1927, XLIII, 368; K. W. F. Kohlrausch, *Phys. Ztschr.*, 1927, XXVIII, 2, J. Thibaud, *Ann. de Phys.*, 1925, V, 119; C. Elhs and W. Wooster, *Proc. Camb. Phil. Soc.*, 1925, XXII, 853; idem, 1925-27, XXIII, 717-729.

<sup>8</sup>It seems likely that the  $\gamma$ -ray spectrum, originating from an atomic disintegration, is not a "white" or continuous spectrum, but a spectrum of discrete lines. As the ray emerges from the atom, however, it doubtless suffers a modification in wave length owing to interaction with the radioactive substance itself and with any filter in its path, converting the separate rays through Compton scattering into a continuous spectrum. Skobelzyn determined the relative intensities of the different wave lengths by the number of recoil electrons of given velocity (corresponding to a given wave length of  $\gamma$  ray) in a Wilson cloud chamber. His curve is "ironed out" in Figure 2 to give a smoother curve than he observed, and Figure 2, therefore, makes the intensity distribution appear more equable than it probably is. There is still some question as to where the limits of the  $\gamma$ -ray spectrum lie. There is evidence of rays at wave lengths greater than 0.040 Å.U., and some suggestion of rays around 0.002 Å.U. The limits of the  $\gamma$  ray spectrum are, therefore, not defined in Figure 2. In addition, Skobelzyn's determina-

The measurements made by Ellis and Wooster suggest a mean wave length for the  $\gamma$ -ray spectrum of 0.008 Å.U., corresponding to a voltage of 1,500,000 volts as indicated in Figure 2, somewhat shorter than the approximate mean wave length to be derived from Skobelzyn's curve. On Figure 2 is also represented the relative intensities found by Terrill and Pine<sup>9</sup> for the various wave lengths in the X-ray spectrum as obtained from a 200,000-volt X-ray tube with a tungsten target after filtering through 1 mm. of copper. It is to be noted that the  $\gamma$ -ray curve in Figure 2 applies to

tion of distribution of intensities rests upon only 160 observed recoil electron paths, a number insufficient to define the intensity distribution curve with high accuracy. The curve given in Figure 2 may, however, be taken as approximately correct. The data from which Figure 2 was plotted refer to  $\gamma$ -rays filtered through 3 mm. of lead.

<sup>9</sup>H. M. Terrill and Mary Pine: Jour. Cancer Research, 1924, VIII, 71.

$\gamma$ -rays after filtering through 3 mm. of lead, whereas the X-ray curve was taken with 1 mm. copper filter. This difference in filters

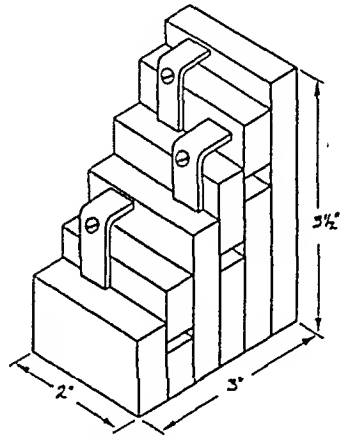


Fig. 8. Diagram of built-up specimen radiographed in Figure 7.

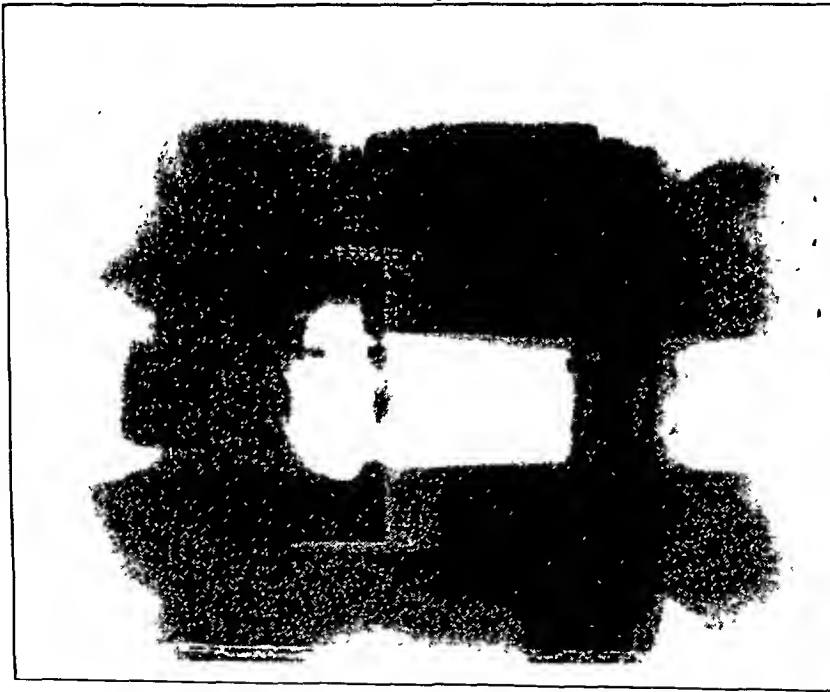


Fig. 9. A tool rest from a lathe. Overall length of section photographed  $8\frac{1}{2}$  in.; height,  $6\frac{1}{2}$  in. (Film No. 2). Distance, source to film, 26 in.; intensifying screen, none; time of exposure, 12 hrs.; mean strength of emanation, 181 millicuries in one bulb. *Results:* Film badly over-exposed. With intensifying screens only a small fraction of the exposure time noted would have been necessary. A high degree of detail was brought out on the original film.

exerts some distorting effect upon the true distribution curves, but for the present purpose the curves given in Figure 2 may be taken as a nearly true index of the distribution of wave lengths in the two spectra.

X-ray bulb or a tube of radium emanation. In Figure 2 the two curves are drawn simply to give approximately equal heights. It is, of course, the much shorter wave length of the  $\gamma$ -ray as indicated in Figure 2 which

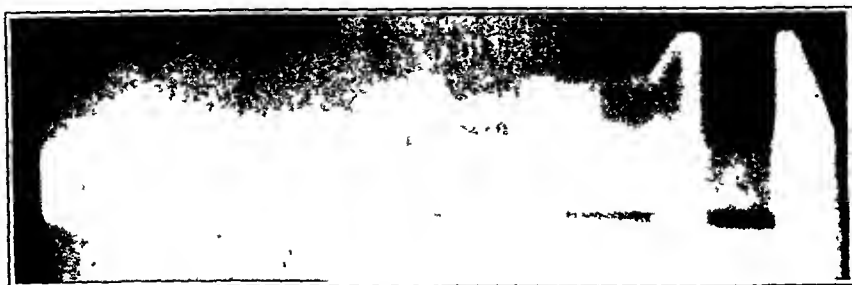


Fig. 10. Wrench,  $8\frac{1}{2}$  in long (Film No. 3). Distance, source to film,  $66\frac{1}{2}$  in.; intensifying screen, none; time of exposure,  $10\frac{1}{2}$  hrs.; mean strength of emanation, 2,181 millicuries in six bulbs. *Results:* All details shown very clearly. Film somewhat over-exposed. Distance from source very great. With a shorter distance and by the use of intensifying screens, a shorter time and a weaker source would have sufficed. Note increase in sharpness of all details in Films No. 1 to No. 3, with increase in distance from source to film, as to be expected. The lack of halo around the edge of the specimen indicates that the usual precautions taken in X-ray radiography to prevent halo are unnecessary when radiographing thin specimens by  $\gamma$ -rays.

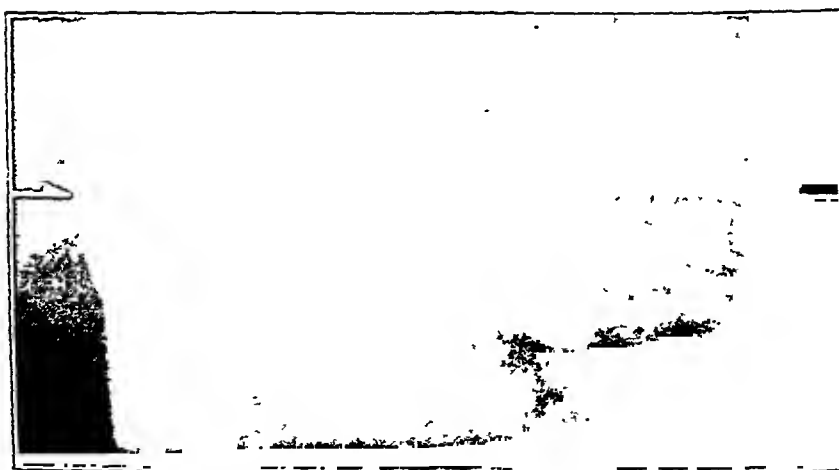


Fig. 11. Faulty weld,  $2\frac{1}{2}$ -in steel plates, lap-welded (Film No 4). Distance, source to film, 30 in.; intensifying screen, none; time of exposure, 12 hrs.; mean strength of emanation, 217 millicuries in one bulb. *Results:* Lack of bond clearly shown (indicated by arrows). This reproduction is not nearly so good as the original film. Exposure excessive. Time of exposure could have been much less, especially by use of Patterson screens.

The areas under the intensity curves in Figure 2 are entirely dependent upon the intensity of the source, whether it be an

accounts for the much lower absorption of the  $\gamma$ -rays in radiography.

*Absorption and Scattering.*—The  $\gamma$ -ray

beam issuing from a bulb of radium emanation has approximately the distribution of wave lengths indicated in Figure 2 (after, as noted, passing through 3 mm. of lead, which absorbs the softer rays preferential-

through simple absorption (converted into heat) and through scattering. This emergent intensity may be represented by an equation

$$I = I_0 e^{-\mu x}$$



Fig. 12. Faulty weld, butt-welded (Film No. 5). Distance, source to film, 30 in.; intensifying screen, none; time of exposure, 12 hrs.; mean strength of emanation, 179 millicuries in one bulb. *Results:* Imperfections clearly shown.

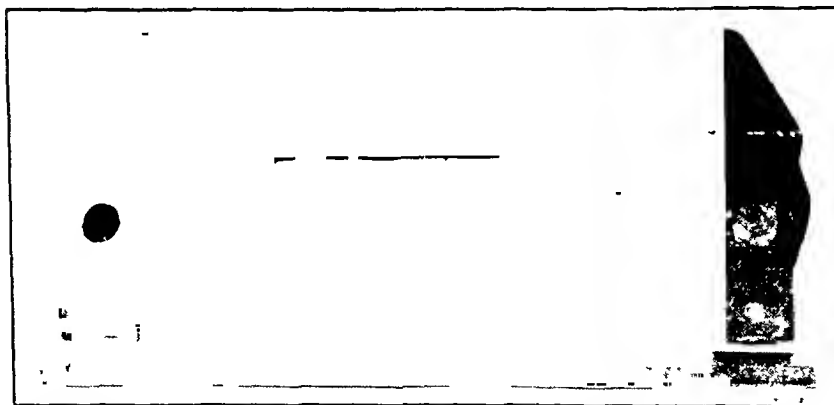


Fig. 13. Photograph of steel casting of which radiographs are shown in Figures 14 and 15.

ly). As this ray passes through a metal object it suffers a number of changes. The emergent ray is complex, as indicated in Figure 3.

The emergent  $\gamma$ -ray beam is weaker than the direct beam because of loss of intensity

where  $I_0$  is the initial intensity (assumed to be a simple wave length),  $x$  the thickness of the absorbing medium, and  $\mu$  the total absorption coefficient.

The total absorption coefficient  $\mu$  is actually affected by two agencies, namely,



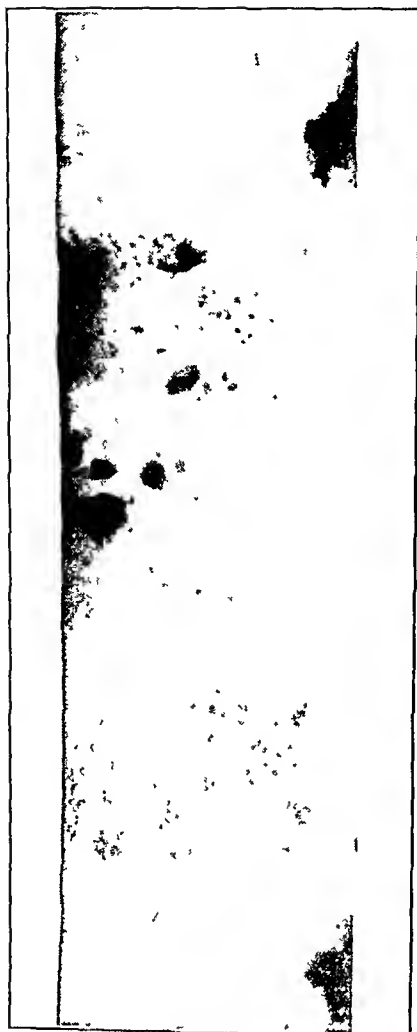


Fig. 14



Fig. 15

Fig. 14 (left) Steel casting with sand inclusions, shown in Figure 13. Thickness of web between ribs,  $\frac{1}{4}$  in. of rib at base, 1 in. (Film No. 6). This X-ray radiograph shows clearly the presence of sand inclusions. The method of photographic reproduction has increased the contrast considerably in Films No. 6 and No. 7. The figure "2" has no significance.

Fig. 15 (right). Film No. 7. Distance, source to film, 30 in.; intensifying screen, none; time of exposure, 12 hrs; mean strength of emanation, 217 millicuries in one bulb. Results: Film darker than necessary. Fairly good reproduction of original film except detail in ribs lost. With Patterson screens the exposure time could have been very considerably decreased.

A comparison between Figures 14 and 15 is important in comparing the  $\gamma$ -ray and the X-ray methods for radiography. Every detail which could be discovered upon the X-ray photograph (Fig. 14) could also be found upon the  $\gamma$ -ray photograph (Fig. 15). The contrast upon the film between a defect and the background is greater upon the X-ray film. Because of the lower absorption coefficient for  $\gamma$ -rays, however, the whole of the casting is satisfactorily exposed upon the  $\gamma$ -ray photograph, whereas the ribs are badly under-exposed upon the X-ray film. It is possible that a better X-ray photograph could be obtained, but it is inescapable that it should be easier to radiograph an irregular section with  $\gamma$ -rays than it is with X-rays. Precautions were taken to eliminate scattering at the edges of the specimen in the X-ray radiograph of this piece (Film No. 6), but not in this  $\gamma$ -ray radiograph. The complete lack of halo at the edges of the casting indicates that such precautions are unnecessary when  $\gamma$ -rays are used on rather thin specimens.

true absorption and scattering. Neither X-rays nor  $\gamma$ -rays from a bulb of radium emanation are homogeneous in wave length (Fig. 2). Accordingly the first absorbing layers remove a large fraction of the less

It has been stated that the total absorption coefficient represents the sum of a true absorption coefficient and a scattering coefficient. The scattered ray is of considerable importance to radiography, since it com-

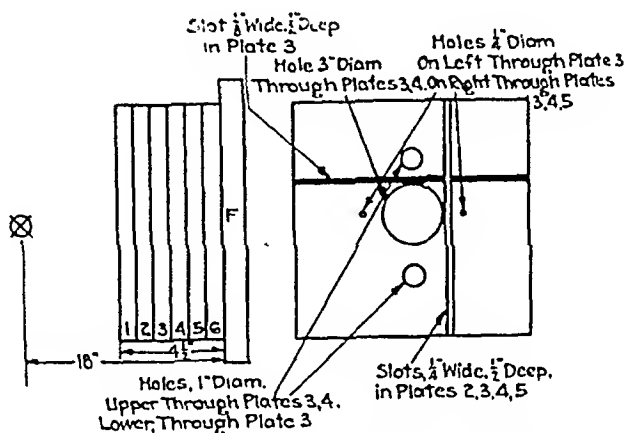


Fig. 16. Diagram showing method of preparing specimen radiographed in Figure 17.

penetrating rays, so that only the more penetrating or "hard" rays reach the final layers. For such non-homogeneous beams the effective value of  $\mu$  is much greater for the rays which enter the absorbing object than for those which leave it. According to Kohlrausch,<sup>10</sup> the total absorption coefficient for  $\gamma$ -rays may be represented by two absorption coefficients,  $\mu_1$ , and  $\mu_2$ , where

$$I = I_0 \left( e^{-\mu_1 x} + 0.75 e^{-\mu_2 x} \right),$$

for iron  $\mu_1 = 0.356$  and  $\mu_2 = 0.632$  cm.<sup>-1</sup>, with an average value in the neighborhood of 0.5 cm.<sup>-1</sup>.

Taking 0.15 Å.U. as the effective wave length of X-rays from a 200,000-volt tube (Fig. 2), the corresponding coefficient for iron is 4.5 cm.<sup>-1</sup>. These coefficients thus indicate the greater penetrability of the  $\gamma$ -rays.

monly fogs the registering film. To combat the scattering, various screening devices have been introduced, such as simple lead shields and the more complicated Potter-Bucky diaphragm.<sup>11</sup>

The scattering of  $\gamma$ -rays differs from that of X-rays owing to the shorter wave length. The difference is in three categories: (a) the fraction of the beam scattered (the magnitude of the scattering coefficient), (b) the angular distribution of the scattered ray, and (c) the modification of the wave length upon scattering<sup>12</sup> (Compton effect).

(a) It is difficult to make any definite statement concerning the ratios of the true absorption and scattering coefficients for X-rays and  $\gamma$ -rays, except that both these coefficients are smaller for  $\gamma$ -rays than

<sup>11</sup>See, among many publications, that of the Eastman Kodak Company, entitled "X-rays in Industry," 1929.

<sup>12</sup>Fluorescent radiation in both the X-ray and  $\gamma$ -ray technic is absorbed before reaching the film and need not be considered here. The ejected photo-electrons suffer a similar fate.

<sup>10</sup>Meyer and Schweidler: Radioaktivität, Teubener, Berlin, 1927, p. 644.

X-rays. There is a lack of data from experiments duplicating radiographic conditions.

(b) The angular distribution of intensity is of peculiar interest in radiography. Both

angular distribution for the former gives approximately the distribution of the total scattering. Figure 4 gives a series of such curves,<sup>13</sup> and indicates that the distribution of the scattered ray should be less detrimental

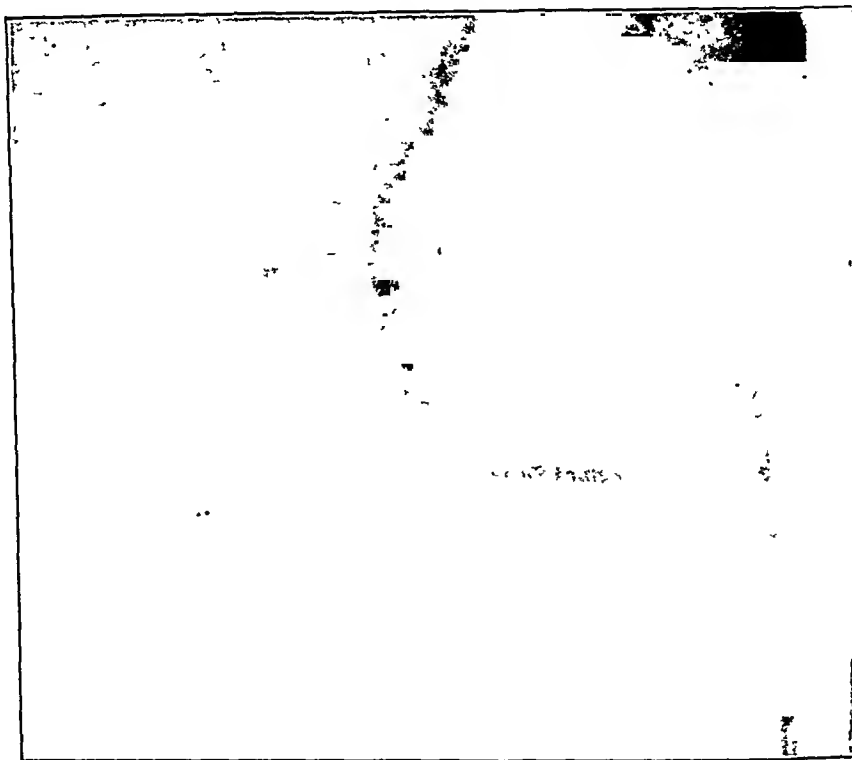


Fig. 17. A series of steel plates, in certain of which were cut holes of several diameters, and slots. Details of arrangement are given in Figure 16 (Film No. 8). Distance, source to film, 18 in.; intensifying screen, film between two Patterson screens; time of exposure, 12 hrs.; mean strength of emanation, 198 millicuries in one bulb. *Results:* Film much darker than necessary. Half the stated exposure time would easily have been sufficient. Contrast on this illustration somewhat greater than on original film. Fogging shown in upper right-hand corner is only very light on the original film. Film covered only part of detailed plate in Figure 16, as may be seen by a comparison of Figures 16 and 17. Smallest hole in left is of particular interest. It appears very strongly here, though it is only  $\frac{1}{4}$  in. in diameter and  $\frac{3}{4}$  in. deep, showing that the  $\gamma$ -ray method in this case brought out strongly a defect  $\frac{1}{4}$  in. in diameter and 17 per cent of the total thickness deep. A similar sensitivity is shown by the lower 1-inch hole. The sensitivity of the method is shown also by the following film.

the modified and the unmodified ray are distributed more in the direction of the primary beam in the case of the shorter wave lengths than in the case of the longer. Under radiographic conditions the modified rays predominate over the unmodified at practically all scattering angles, so that a curve of

tal to the production of good  $\gamma$ -ray radiographs than to good X-ray radiographs

(c) The scattered  $\gamma$ -ray beam suffers a profound modification through the operation of the Compton effect, and in this

<sup>13</sup>W. F. Kohlrausch: *Handbuch der Experimentalphysik*, Vol. XV, p. 132.

respect differs greatly from X-rays. The Compton scattering is an increase in the wave length of the primary beam, the amount of increase dependent upon the angle the scattered beam forms with the

the angular distribution of the scattered  $\gamma$ -ray beam, since the beam scattered at the greater angles will be more rapidly absorbed by the specimen.

These various considerations indicate that

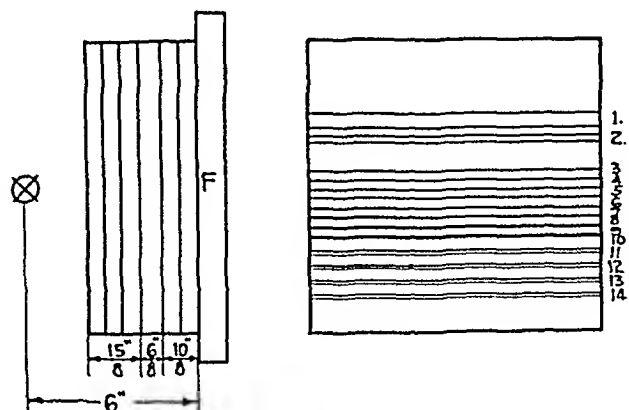


Fig. 18. Diagram showing method of preparing specimen radiographed in Figure 19. Dimensions of slots were as follows:

| No. | Width in mm. | Depth in mm. |
|-----|--------------|--------------|
| 1   | 13           | 13           |
| 2   | 6            | 13           |
| 3   | 1            | 2            |
| 4   | 1            | 3            |
| 5   | 1            | 6            |
| 6   | 1            | 12           |
| 7   | 2            | 2            |
| 8   | 2            | 3.5          |
| 9   | 2            | 6.5          |
| 10  | 2            | 12           |

primary beam but independent of the original wave length. A beam scattered at an angle 90 degrees to the primary beam suffers an increase in wave length of 0.024 Ångström unit. Such an increase will make only relatively little difference in the scattered X-ray wave lengths (since the effective wave length of the primary beam from a 200,000-volt tube is about 0.15 Å.U.), but will make a great difference in the scattered  $\gamma$ -ray wave lengths (which are principally between 0.030 and 0.004 Å.U.), dependent upon the angle of scattering.

The scattered  $\gamma$ -ray beam will, therefore, have a much greater wave length at large angles and a proportionately much greater absorption coefficient. This will, in effect, so far as radiography is concerned, narrow

scattering from  $\gamma$ -rays should not be a greatly harmful influence in  $\gamma$ -ray radiography, and the degree of success attained in the experiments soon to be described bears testimony to the correctness of this viewpoint.

*Photographic Exposure Characteristics.*—A great deal has been written about photographic exposure characteristics for radiography by the use of X-rays. The information desired is simply the shortest exposure time for a given thickness of metal necessary to reveal upon the developed photographic film the density differences—defects—occurring in the object inspected.

There is a fairly wide latitude in the choice of exposure times for different thicknesses, dependent upon the observer's taste

in film density and upon what deviations from the simplest technic are used, such as

lute blackening is determined by photometric measurements in which the intensity of the

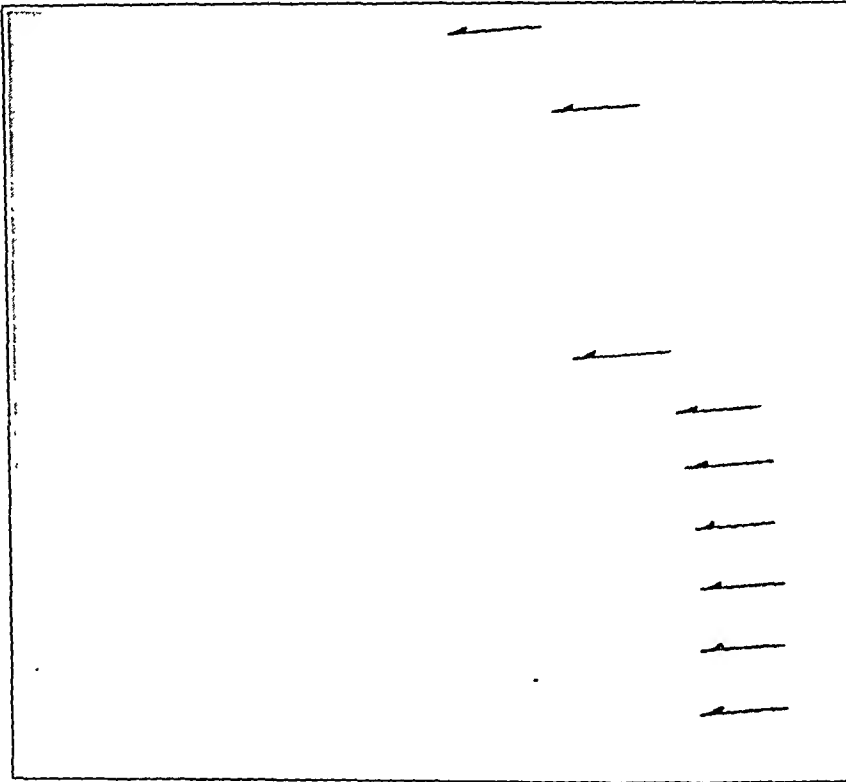


Fig. 19. A series of steel plates, total thickness  $3\frac{7}{8}$  in., in one of which (marked "6/8" in Figure 18) a number of slots of varying depth and width were cut. Details are given in Figure 18. The slotted side of the plate was turned towards the film (Film No. 9). Distance, source to film, 6 in.; intensifying screen, none; time of exposure, 4 hrs.; mean strength of emanation, 179 millicuries in one bulb. *Results:* This radiograph was taken to test the sensitivity of the  $\gamma$ -ray method for small defects. It must, of course, be borne in mind that the slots illustrated in Figure 18 are well defined geometrically, which is favorable to the test. The original film was nearly of correct exposure, though the use of Patterson screens would have decreased the exposure time. Owing to the close proximity of the source, there is a greater density in the center of the film than at the edges. The great divergence of the rays at the edges likewise had the effect of spreading out the registration of the slots, and this effect, coupled with the diminution of intensity of the ray, made certain of the slots far from the center not visible on the film. Especial attention should, however, be given the five slots registered near the center. The third arrow from the top indicates the photographic result from Slot No. 3 in Figure 18, which was 1 mm. wide by 2 mm. deep. Under the conditions of this experiment, therefore, a defect 1 mm. wide and only 2 per cent of the total thickness deep was detected. The second arrow from the top indicates the photographic result of Slot No. 2. Slot No. 1 is only faintly indicated (top arrow) for the reasons stated above.

enhancing screens, special developing methods, and special film-inspecting methods.

To eliminate the fancies of the observer, exposure curves may be given to represent the proper exposures for a given degree of absolute blackening of the film. The abso-

light is measured thermoelectrically. The degree of blackening, or density, is then given by the expression

$$D = \log_e \frac{I_0}{I} = 2.3 \log_{10} \frac{I_0}{I}$$

where  $D$  = density,  $I_0$  = intensity of primary beam, and  $I$  = intensity of transmitted beam.

A density of  $D = 1.15$  is sometimes taken as a satisfactory degree of blackening

$$x = \frac{1}{\mu} \log_e kt$$

where  $x$  is the thickness,  $t$  is the time of exposure required for a given blackening

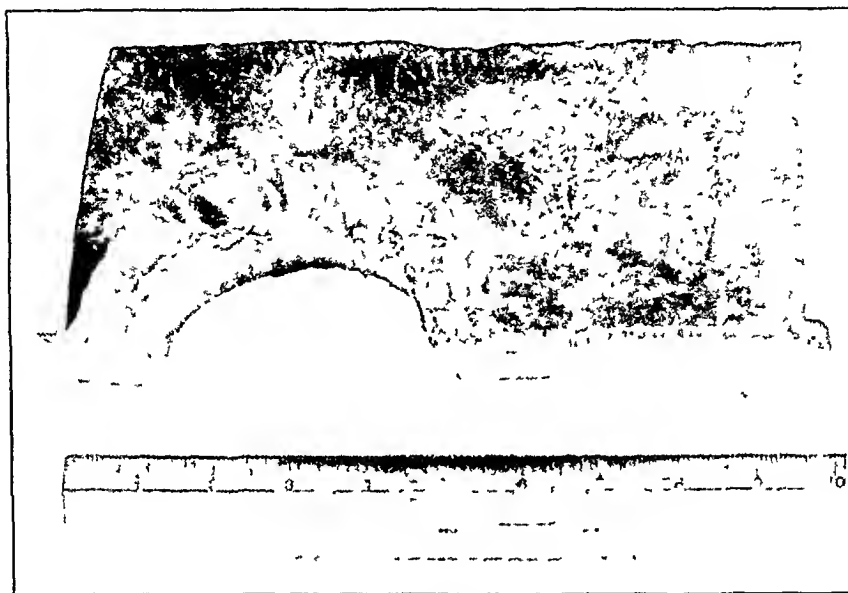


Fig 20 Steel casting 1 in thick, with cracks See Figures 21 and 22 for radiographs.

for radiographic purposes.<sup>14</sup> This density refers to the increase in density above that of the unexposed but developed film.

Figure 5 gives such exposure curves for X-ray tubes operating with a tungsten target<sup>15</sup> at the indicated voltages (D. C.). There is at present no exposure curve available for  $\gamma$ -rays.<sup>16</sup> Neglecting scattering and non-homogeneity of wave length, an exposure curve should have a slope inversely proportional to the linear absorption coefficient of the ray used (when plotted in the usual way, thickness against the logarithm of milliamperere-seconds). Mathematically

(for a constant tube milliamperage in the case of X-rays or for a constant millicurie strength in the case of  $\gamma$ -rays),  $\mu$  is the linear absorption coefficient as before, and  $k$  is a constant depending upon experimental conditions. A change in  $\mu$  is, therefore, much more effective in changing  $x$  than a change in  $t$ , since the logarithm of  $t$  changes very slowly with  $t$ . In other words, to increase the thickness range in radiography, a decrease in wave length is much more effective than an increase in time. To illustrate: Consider the difference in exposure time for 3 inches and 6 inches of iron. From Figure 5 the exposure time for 3 inches with a 220,000-volt X-ray tube is 3,000 milliamperere-seconds (50 milliamperere-minutes), requiring an exposure time of about 10 minutes at a milliamperage of 5. Extrapolating the exposure curve for a 220,000-volt tube

<sup>14</sup>In Briggsian logarithms a density of 0.5

<sup>15</sup>Adapted from "Der gegenwartige Stand der Rontgen durchstrahlung von Metallen," Siemens Reiniger-Veifa, Berlin, 1928

<sup>16</sup>Some attempts were made to procure such curves by a technic which later proved inadmissible. It is hoped shortly to obtain exposure curves to be used in practical  $\gamma$  ray radiography. The radiographs reproduced in this paper are not of uniform density, nor are they all of the lowest practicable density, so that the exposure times cannot be taken as a guide except in a rough way

type D. E. Q.<sup>19</sup> Readings were taken with a Leeds and Northrup galvanometer.<sup>20</sup>

A lead block with a longitudinal hole was placed between the  $\gamma$ -ray source and the ionization chamber, and served to define a

beam necessary, requiring very high sensitivity in the ionization apparatus. In addition, extremely good insulation would be required, a troublesome matter.

Since these experiments were made tech-

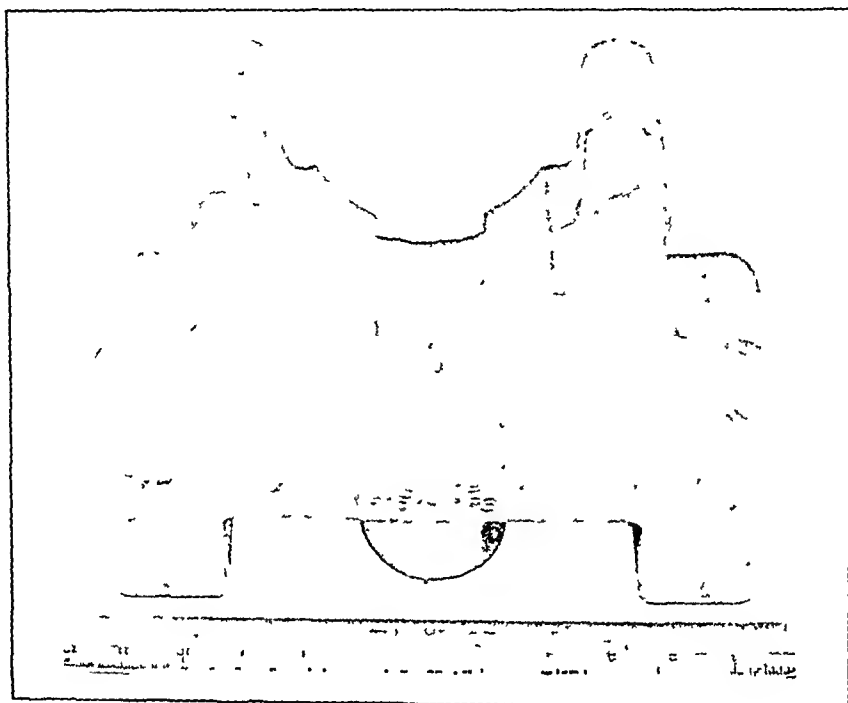


Fig 23 Bronze casting radiographed in Figure 24

beam half an inch in diameter. Steel blocks of different thicknesses were placed between the lead block and the source. With a 218-millicurie source 10 inches from the front of the ionization chamber it was just possible to detect (in the ionization current) the difference between 7 and 8 inches of steel. In other words, a hole 1 inch deep and  $\frac{1}{2}$  inch in diameter could have been detected in 8 inches of steel. Continuing, it was found that a difference could just be detected between 5 and  $5\frac{1}{2}$  inches of steel.

In any ionization method the width of the chamber slit is a limiting factor. To detect small imperfections a very narrow slit would

be necessary in the measurement of small currents has been developing rapidly. It is now possible to measure currents smaller than these with rugged and portable equipment. Any comparison of these results with the photographic results so far as sensitivity is concerned would accordingly be premature.

In order to obtain a record of the opacity of an object by any ionization method it would be necessary, however, to scan the area studied and to chart the variations in ionization current obtained. Such a method would be troublesome, though possibly some automatic scanning device might be worked out.

(b) As noted in the beginning of the paper, thin sections of metal had been radi-

<sup>19</sup>Amplification factor 20, impedance 100,000 ohms  
<sup>20</sup>Sensitivity 0.7 mm per microvolt, 46 ohms resistance,  
 100 to 500 ohms shunt

ated by means of  $\gamma$ -rays and the emergent beam observed upon a fluorescent screen years ago by Rutherford. Repetition of this experiment showed the effect to be striking. A moment's consideration, how-

#### RADIOGRAPHY BY MEANS OF $\gamma$ -RAYS

In all, several hundred photographs were taken of divers objects. The authors had at their command the radiographic technic

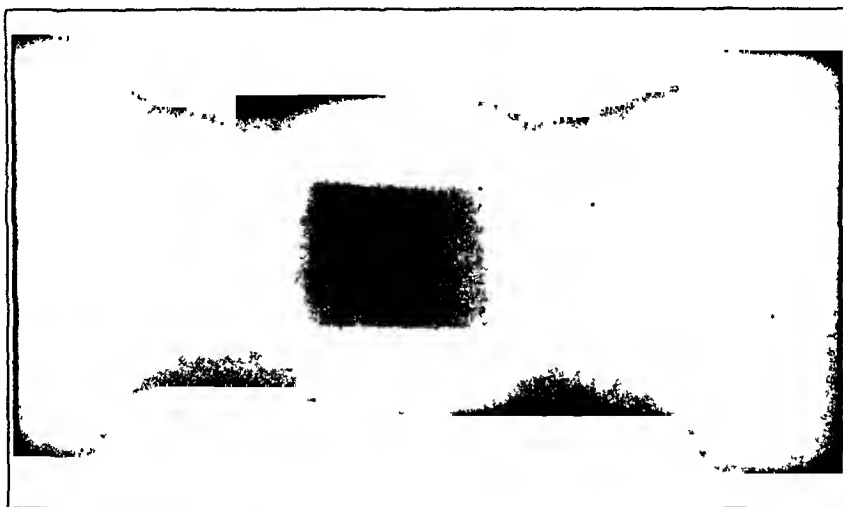


Fig. 24. An irregular bronze casting, a photograph of which is shown in Figure 23 (Film No. 12). Distance, source to film, 26 in.; intensifying screen, none; time of exposure,  $10\frac{3}{4}$  hrs.; mean strength of emanation, 2,100 millicuries in six bulbs. *Results:* Film exposed somewhat more than necessary. Exposure time and strength of emanation could have been further reduced by the use of Patterson screens. Absorption of bronze is greater than that of steel, requiring a somewhat stronger source or a somewhat longer exposure time. A picture taken simultaneously, with film between two sheets of lead foil, gave slightly better contrast but approximately the same density. Note the small flaw in the upper right-hand corner of the casting.

ever, is sufficient to discover the inadequacy in such a method, for only very thin sections may be successfully inspected and in such cases no radiographic method is needed unless it be the X-ray.

(c) Although at the beginning of this work it was thought that an ionization method of recording the emergent beam was to be preferred because of the speed with which a record might be obtained, it was found that the photographic method yielded surprisingly good results and the work continued by this method entirely. Agfa and Eastman double-emulsion X-ray films were used exclusively.

so completely developed for X-rays, but little use was made of many of its details, for, in a pioneer attempt, such as this, it is more economical of time to discover a few essential facts before much endeavor is made towards refinement. Of these many photographs only a selected few are reproduced here, chosen to demonstrate the general nature of the results obtained. The chronology of the experiments performed was not that indicated by the sequence of photographs in this paper, so that there is lacking the indication of improved quality, resulting from experience, observed during the course of the work.



Without any initial conception of exposure times it was inevitable that many photographs should show too little or too much exposure. This may be noted even in the photographs reproduced here, with a

hanging screen, some using a Patterson calcium-tungstate screen, and some using a lead backing as an enhancing screen.

For these various reasons the exposure times noted for the various photographs

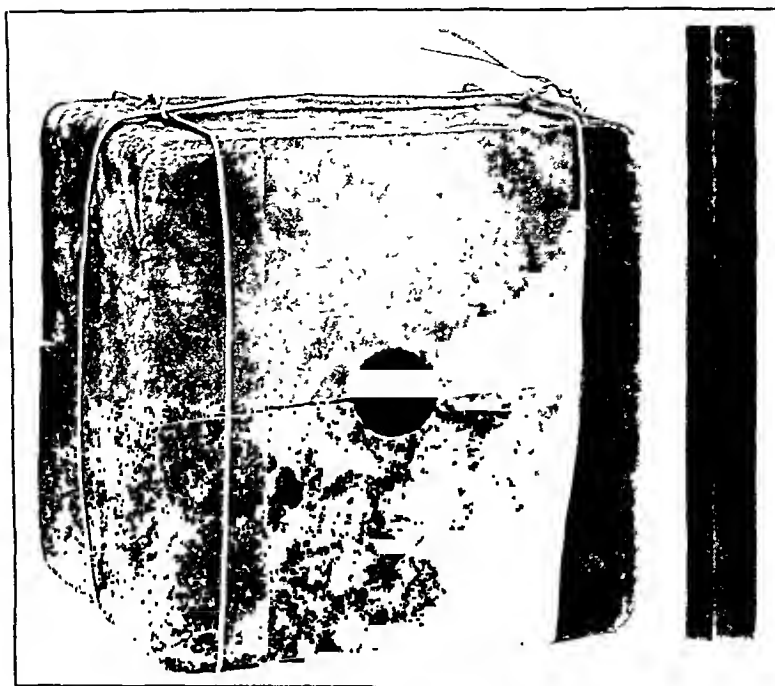


Fig. 25. Block of cast iron with a large hole leading off one face. Assembled after cutting and radiographed in Figure 27.

tendency toward over-exposure. For obvious reasons the shortest possible exposure time is desired. Some films were exposed "plain," that is, without the use of an en-

hancing screen, some using a Patterson calcium-tungstate screen, and some using a lead backing as an enhancing screen. For these various reasons the exposure times noted for the various photographs

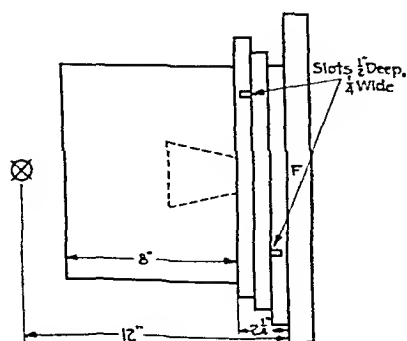


Fig. 26. Diagram of method of preparing specimen shown in Figure 25 and radiographed in Figure 27.

must be regarded carefully.<sup>21</sup> Considering also the fact that most of the films were over-exposed it is obvious that the exposure times noted could have been less.<sup>22</sup>

The specimens radiographed were chosen to represent the important features commonly found in radiography. They include "synthetic" specimens, that is, specimens built up of plates with holes, slots, and so

<sup>21</sup>Estimations of this reduction in exposure time vary. The booklet, "Der gegenwärtige Stand der Röntgendurchstrahlung von Metallen," published in 1928 by Siemens-Reiniger-Verfa, states (page 9) that the exposure time may be shortened to from  $\frac{1}{8}$  to  $\frac{1}{100}$ , dependent upon the wave length of the ray, the shorter rays giving a proportionately greater saving in time. This would indicate a great saving for  $\gamma$ -rays but as yet no determination has been made.

<sup>22</sup>It is obvious that any development in photography toward shortened exposure times would be of the greatest importance to  $\gamma$ -ray (or X-ray) radiography. Recent experiments in this Laboratory indicate the development of a method which will reduce the exposure time to at least one-half of that now necessary.

on, simulating cracks, voids, and inclusions actually found as defects in metallurgical materials. It was considered best to work first with such synthetic specimens, since the utter lack of previous work made all results

nic is extraordinarily simple. Many of the photographs were taken upon the table illustrated in Figure 6. The thistle tube rising from the center of the table held the radium emanation. Specimens were dis-



Fig. 27. The block of cast iron shown in Figure 25, with three  $\frac{3}{4}$ -in. steel plates, with slots, as shown in Figure 26. Distance, source to film, 12 in.; intensifying screen, none; time of exposure,  $10\frac{3}{4}$  hrs.; mean strength of emanation, 2,100 millicuries in six bulbs. *Results:* Exposure of film nearly correct. Photographic reproduction of Film No. 13 made by photographing film laid upon sheet of white paper. This was found to be a very satisfactory way of viewing negatives that are not too dense. The large hole is very clearly visible; also, the slots in the plates may be seen to right and left of the large hole, indicated by arrows. Exposure time and strength of emanation could have been reduced considerably by the use of Patterson screens. A 1-in. hole in the top and another in the bottom were drilled after taking the radiographs, to facilitate cutting up the specimen, so that naturally they do not appear in any of the radiographs.

uncertain. In addition to such specimens there are included radiographs of a cast iron block with defects, a steel casting with surface cracks, a steel casting with sand inclusions, a bronze casting, and two imperfect welds.

It should be clear, from what has been said, that the necessary equipment and tech-

tributed radially around this, as indicated by the guides on the table top which served to orient the specimens and the photographic film holders. The technic of taking  $\gamma$ -ray radiographs consisted simply in mounting the metal object to be photographed upon the stand (if the stand were used), aligning it with the thistle tube, adjusting the holder

containing the film at the rear of the object, lowering the metal capsule containing the bulb of radium emanation in the thistle tube, and receiving the film holder at the

is, spherically. In appraising the cost of such a method of inspection this feature must be remembered.

#### γ-RAY RADIOGRAPHS

The descriptive matter accompanying the radiographs needs a word in explanation.

The technic described in the third paragraph above was always used, except that certain objects were photographed upon the floor. Diagrams of the relative positions of the emanation, object, and film holder are given only when necessary.

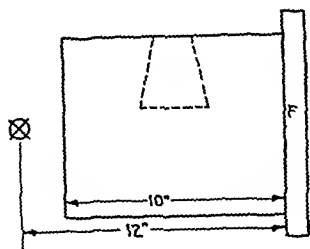


Fig. 28. Diagram of method of preparing the specimen radiographed in Figure 29.

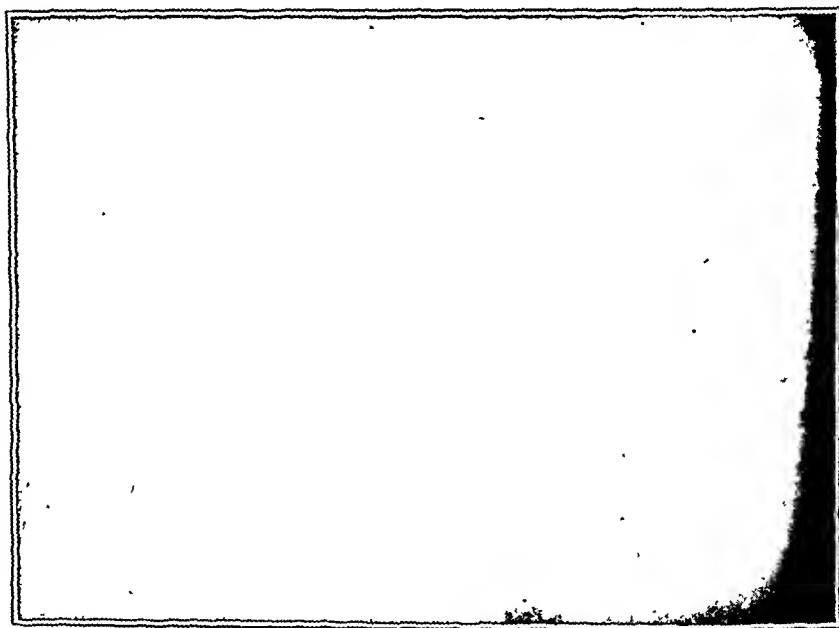


Fig. 29. Same as with Film No. 13 (Fig. 27), except without steel plates. Hole on the side of casting, as shown in Figure 28. Distance, source to film, 12 in.; intensifying screen, one Patterson screen; time of exposure, 8 hrs.; mean strength of emanation, 1,150 millicuries in two bulbs. *Results:* Original film imperfect, giving a "spotty" radiograph. The hole in the side is clearly visible, but distorted owing to divergence of the beam. Film is badly over-exposed.

expiration of the exposure time. The films used and the developing procedure were similar to those in X-ray radiography.

It is an important feature of this method that many specimens may be arranged around the γ-ray source, for the radium emanation emits γ-rays in all directions, that

"Distance, source to film," refers to the distance, in inches, from the bulb of radium emanation to the film holder. The information listed after "intensifying screens" is self-explanatory, as is that after "time of exposure." "Mean strength of emanation" refers to the radiating strength of the

emanation half-way through the exposure. The strength of the emanation was, therefore, somewhat greater at the beginning of

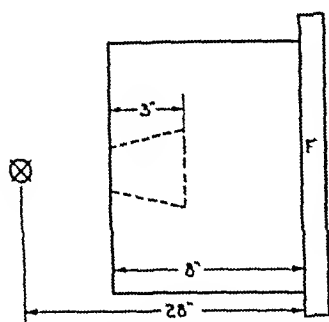


Fig. 30. Diagram showing method of preparing specimen radiographed in Figure 31.

the exposure and somewhat less at the end than that of the value given (see Fig. 1).

Under "Results" are listed a few essential features in the radiograph to which it is desired to call attention. Several of the  $\gamma$ -ray radiographs are accompanied by X-ray radiographs of the same object for purposes of comparison.

The radium emanation was held in a small ( $\frac{1}{8}$  inch in diameter) glass capsule, enclosed in a brass sheath,  $\frac{1}{2}$  inch in length,  $\frac{3}{16}$  inch in diameter. In several cases, when strong sources were used, more than one of these containers were used, as will be noted. The use of several containers is not to be recommended in general, since it increases the dimensions of the radiating source and, therefore, operates against a high degree of definition in the resulting radiograph.

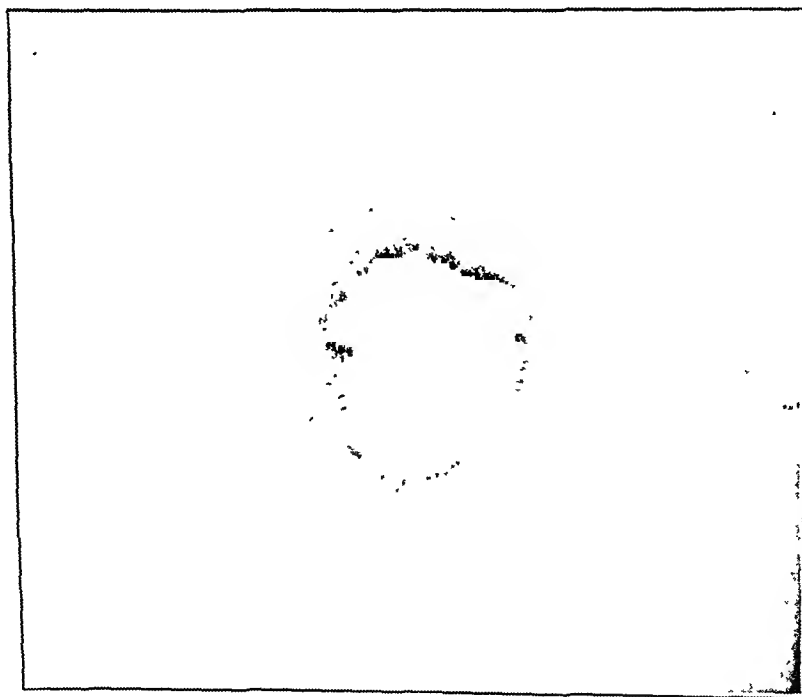


Fig 31. Same as with Film No. 14 (Fig. 29). Hole towards source, as shown in Figure 30 (Film No. 15). Distance, source to film, 28 in.; intensifying screen, one sheet of lead foil; time of exposure,  $10\frac{1}{2}$  hrs.; mean strength of emanation, 2,181 millicuries in six bulbs. *Results:* Exposure greater than necessary. The larger hole may be clearly seen. In addition to this, there may be discovered in the original of Film No. 15 a cloud-like image floating over the large hole and downwards slightly to the right. This suggested a defect in the back of the block, which, upon cutting, was found—see Figure 32.

The usual difficulty in photographic reproduction of the original radiographs for publication was experienced, perhaps somewhat more severely, for the  $\gamma$ -ray radiographs do not show as great a contrast as

scientific fashion the use of  $\gamma$ -rays for the radiographic detection of defects in metallurgical material. It does not, therefore, present a finished testing method to industry; nor is there any attempt to analyze the

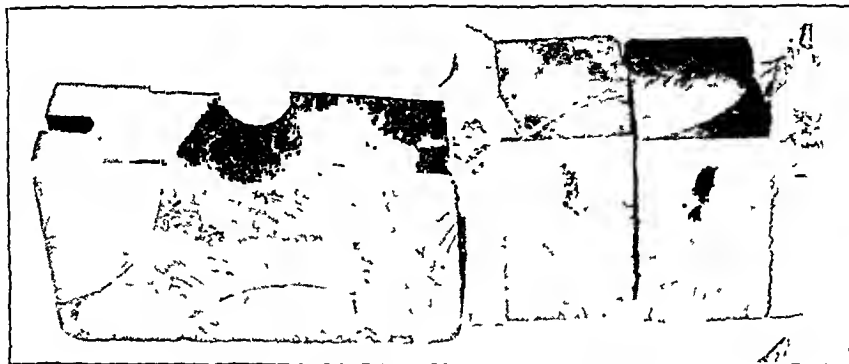


Fig 32 Defects in block shown in Figure 31

the ordinary X-ray radiographs. The films were mounted on wooden frames, inserted in a light-tight viewing cabinet, and photographed with a brilliant source of illumination

at the rear. Best results were obtained with process plates (Wratten M) and with printing upon contrast paper (Azo glossy, type No 4). It is inevitable that the published reproductions of the original radiographs should be unsatisfactory. In the case under "Results" are given a few sentences comparing the reproduction with the original film.

The first three films, respectively of an echelon of steel plates, a lathe tool rest, and a wrench, were taken merely to test the sensitivity of the  $\gamma$ -ray radiographic method for detail. These are all within the X-ray range of thickness.

#### DISCUSSION AND SUMMARY

The aim of the present work may be stated in simple terms: it is an attempt to appraise in a preliminary and in a purely

economics in any possible commercial exploitation. This latter task must be left to those whose interest might make such a testing method desirable.

The results attained are those illustrated by the  $\gamma$ -ray radiographs and itemized under "Results" in the appended descriptions. To complete the appraisal possible at this time these results should now be recapitulated; and, furthermore, the practical features surrounding the use of a  $\gamma$ -ray method of inspection should be set forth.

The physics of  $\gamma$ -rays (developed from the standpoint of radiography) in the Introduction indicates that  $\gamma$ -rays, because of their shorter wave length (Fig. 2) and correspondingly lower absorption coefficient, should be able to penetrate thicknesses of metal with a smaller loss of intensity than X-rays, and, moreover, for the same reason, should not require for great thicknesses the relatively tremendous increase in exposure time characteristic of the X-ray wave lengths now commonly in use.

It is a corollary that the transmitted beam

should register defects upon a photographic film with a contrast inferior to that obtained with the present radiographic X-ray wave

lengths. This diminished contrast is an inevitable resultant of the shorter wave length, and is, of course, not peculiar to the radia-

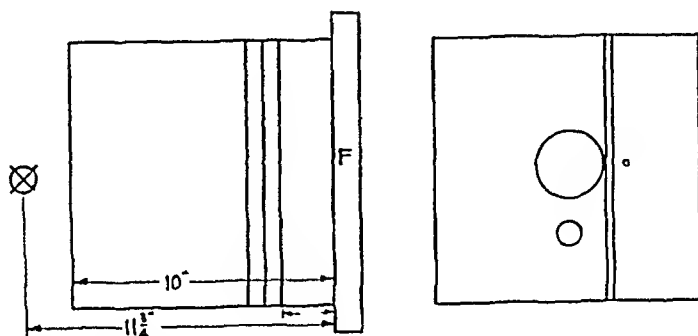


Fig. 33. Diagram showing method of preparing specimen radio-graphed in Figure 34.

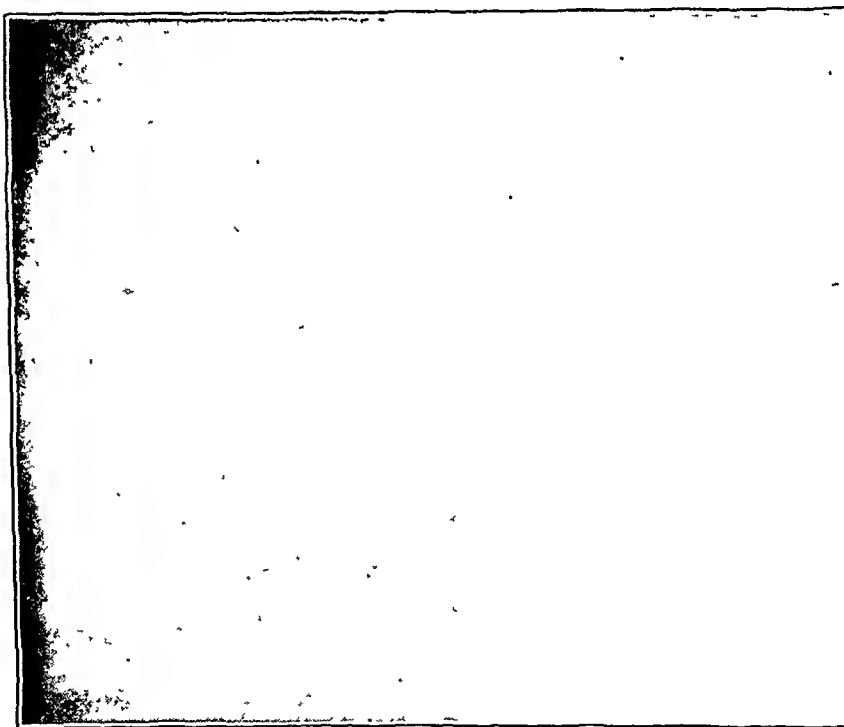


Fig. 34. Pile of steel plates, total thickness 10 in., with holes and slots in two plates, as indicated in Figure 33. The positions of the two plates bearing the holes and slots are indicated in the 10-in. section in Figure 33. The rest of the section was made up of plain plates (Film No. 16). Distance, source to film,  $12\frac{1}{4}$  in.; intensifying screen, none; time of exposure,  $10\frac{3}{4}$  hrs.; mean strength of emanation, 2,100 millicuries in six bulbs. *Results:* Under-exposed. Another film, taken simultaneously with two Patterson screens, had nearly correct density for viewing by reflected light when backed by white paper; by mistake, the poorer of the two was sent for reproduction (authors' note). On both, the hole 3 in. in diameter by  $1\frac{1}{2}$  in. deep is shown clearly, while the hole 1 in. in diameter by  $1\frac{1}{2}$  in. deep is barely seen. On the better film both slots are faintly recorded. The  $\frac{1}{4}$ -in. holes do not appear. A single bulb, with a correspondingly longer time, would have considerably improved the definition in this and several other films.

tion originating from the decomposition processes in radium emanation; development of higher voltage X-ray radiography would lead to a similar circumstance.

It was also indicated in the Introduction

As to be expected, enhancing screens (of calcium tungstate) are very effective in reducing exposure times, though the actual saving in time has not been defined. Lead foil likewise proved effective in shortening

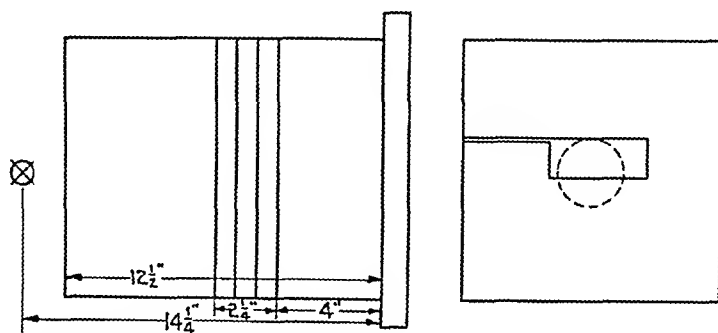


Fig. 35. Diagram showing method of preparing specimen radiographed in Figure 36.

that the scattering of  $\gamma$ -rays (Fig. 4) should not be inimical, and that, in fact, the almost complete absence of "back-scattering" (scattering at an angle of 180 degrees and thereabouts to the primary beam) is an especially favorable feature of  $\gamma$ -rays, for it is unnecessary to take the precautions (various types of shielding) which are a necessary part of X-ray radiography. It may be said that the experiments performed appear to bear out these views.

Radiographs have been taken of objects the thickness of which exceeds that thickness now possible to radiograph with X-rays within reasonable exposure times, that is, from four to ten inches of steel. The minimum exposure times for such thicknesses have not been defined. If it should appear desirable to develop a  $\gamma$ -ray radiographic method for practical use, it will be necessary to work out a correlation of strength of source, time of exposure, and photographic result. In such an eventuality especial attention will have to be given to methods by which the exposure time, at best rather long with  $\gamma$ -rays, can be reduced to a minimum.

exposure times. The use of multiple films is effective in making visible to the eye dimly developed images, and this technic is to be recommended to eliminate from consideration possible spurious effects originating in defective films. It has been found very useful to view the developed film in good light upon a piece of white paper. The enhancing effect of this device is startling. Film No. 13 (Fig. 27) was photographed in this way.

The diminished contrast is illustrated especially by Figures 14 and 15 and Figures 21 and 22. This diminished contrast is not necessarily an argument against the use of  $\gamma$ -rays, especially in the upper ranges of thickness, but it means that importance must be given to slight density discontinuities on the developed film. No detail shown in Figure 14 is absent from Figure 15; it merely appears with diminished contrast. This diminished contrast originating in a lower absorption coefficient has one advantage: it facilitates the radiography of irregular sections, for it is an easier matter with  $\gamma$ -rays to obtain the whole of an irregu-

lar object at a correct exposure than it is with X-rays. This, likewise, is shown by Figures 14 and 15.

Although no efforts were made to prevent scattering in these experiments, no poor re-

small defects seems satisfactory, though in the absence of extensive experimentation there may be some uncertainty on this score. Despite the fact that Film No. 9 was taken upon a "synthetic" specimen, the certain

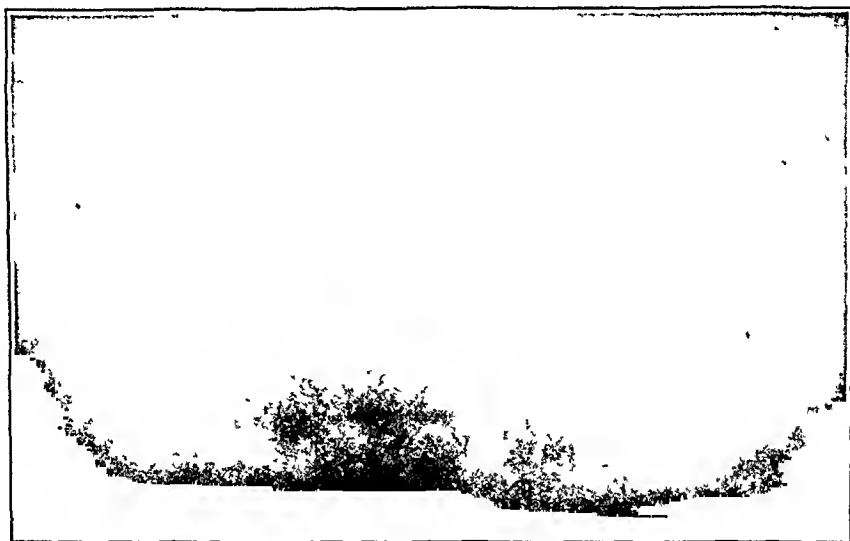


Fig. 36. A series of steel plates having a total thickness of  $12\frac{1}{2}$  inches. All the plates were plain except three near the center, as indicated in Figure 35. Two of these were the plates illustrated in Figure 33, the third illustrated on the right of Figure 35, which shows the alignment (Film No. 17). Distance, source to film,  $14\frac{1}{4}$  in.; intensifying screen, one Patterson screen on each of two films; time of exposure,  $10\frac{1}{2}$  hrs; mean strength of emanation, 2,181 millieuries in six bulbs. *Results:* Under-exposed. The photographic reproduction was done with rear illumination with two films (taken simultaneously) superimposed. The films were held at an angle during reproduction in an attempt to bring out more strongly the dark area in the center. Within the range of intensities and exposure times available during these experiments, this film shows that the thickness for satisfactory radiographs has been exceeded. Our opinion is, however, that a longer exposure and a source of smaller dimensions would allow this and probably greater thicknesses to be radiographed.

sults were obtained which could be ascribed to this cause. Thus Films No. 3, 11, 15, and 17 were made simultaneously, as were Films No. 12, 13, and 16, with the objects close together and several of them of very considerable mass, yet fogging appears to be unimportant on these films. This, taken with the fact that portions of the film exposed to the primary beam are not so badly overexposed when  $\gamma$ -rays are used as when X-rays are used, explains the lack of halo at the edges of the specimens.

The sensitivity of the  $\gamma$ -rays towards

identification of a slot only 2 per cent of the total thickness is promising. The discovery of the defect in the cast iron block upon Film No. 15 was, of course, somewhat gratifying.

The above discussion is all built upon the photographic registration of the transmitted beam. For reasons already given it is believed that fluoroscopic methods are not feasible and that at present the photographic method is superior to methods by which the intensity of the transmitted beam is registered by means of its ionizing effect.



The practical features surrounding the use of  $\gamma$ -rays for radiography are so greatly different from those of X-rays that care must be taken in comparing practical application of the two methods.

The technic of  $\gamma$ -ray radiography is extremely simple. There is required merely a source of  $\gamma$ -rays of suitable strength (radium or radium emanation) mounted simply (Fig. 6, for example), the object to be radiographed placed at a suitable distance—defined by the strength of the source, the thickness of the object, the exposure time desired, and the definition required—and a photographic film, with or without intensifying screens, placed behind the object.

During the exposure no attention need be given and the operator may leave, returning at the expiration of the necessary exposure time. There is, of course, no high voltage equipment to be attended, nor are there any permanent high voltage leads to the source. In fact, the set-up could be arranged at almost any conceivable place, for everything is entirely portable and rugged.

The emission of  $\gamma$ -rays cannot be controlled. Whether or not the radio-active source is being used for radiographic purposes, it will continue to emit  $\gamma$ -rays. It would be advisable, therefore, to make as continuous use of the source as possible during the time it is in the possession of the operator.

Since  $\gamma$ -rays are emitted in all directions—that is, spherically—the source might be completely surrounded by objects to be radiographed. Because of the inverse square law governing the diminution of the intensity with distance from the source, it is unimportant whether a large number of objects be radiographed at a considerable distance with a long time of exposure, or a small number at a short distance with a brief time of exposure; in either case the profitable use made of the  $\gamma$ -ray would be the same, with the qualification that a greater

degree of definition would be obtained at the greater distances.

With a constant source of  $\gamma$ -rays and a large number of objects of varying dimension to be radiographed suitable exposures might be obtained either by varying the time of exposure, or by placing the thinner objects at greater distances and keeping a constant time of exposure for the whole arrangement. This latter scheme was followed in preparing Films No. 3, 10, 15, 17 and Films No. 12, 13, 16.

In the use of  $\gamma$ -rays, as in the use of X-rays, protection must be given the operator against the harmful effects of the rays. It would hardly be useful here to describe in detail the precautions the medical profession has found necessary, except possibly to mention those affecting the technic of operation. Distance, of course, is the best protection, and since no attention during exposure is required, this requirement may easily be met. The emanation is usually transported in a small but heavy-walled lead box and the emanation handled with forceps. These are probably the only details to be mentioned. The authors have been assured by medical practitioners that there should be no objection to the use of  $\gamma$ -rays for the purpose suggested here, originating in possible harmful effects to the operator.

#### ACKNOWLEDGMENT

The authors wish to express their obligation to a number of persons who rendered valuable assistance during the course of this work: to Dr. Howard A. Kelly, of the Howard A. Kelly Hospital, Inc., of Baltimore, Md., who granted us permission to make use of his supply of radium emanation, and especially to Dr. F. West, Superintendent of the hospital, who attended to our various needs during the work with the greatest of consideration and helpfulness; to Prof. A. F. Kovarik, of the Department of Physics, Yale University, who discussed the problem with us previous to the begin-

ning of the work; to Dr. H. H. Lester, of the Watertown Arsenal, Watertown, Mass., who rendered assistance from time to time during the work; to Prof. J. B. Hoag, of the Department of Physics, University of Chicago, who made some preliminary ex-

periments for us upon photography with  $\gamma$ -rays; to J. T. Gow, of this Laboratory, who lent assistance in many ways during the prosecution of the work, and finally, to Captain E. G. Oberlin, U. S. N., whose sympathy with research made this work possible.

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The Radiophysiological and Medical Sections of the Radium Institute of the University of Paris. Cl. Regaud. *Radiophysiologie et Radiothérapie*, 1930, Vol. II, Fasc. 2, p. 157.

The main value of this paper lies in a detailed discussion of the requirements for an efficient organization for the treatment of disease by radiations. The author emphasizes the fact that X-ray diagnosis and therapy are separate and distinct branches of medical science, while X-rays and radium are ever becoming more closely associated, particularly in the treatment of malignant disease. It is undesirable that an institute for radiation

therapy should be limited to the treatment of cancer, but benign conditions which are capable of radiation treatment should also be included. The organization should include an efficient pathological and experimental service, and facilities should also be available for surgery. All departments should be under the control of specialists in the appropriate branches. Finally the necessity is stressed for a well organized secretariat which should have charge of all the clinical, pathological, and other notes relating to all patients, and should be responsible for insuring the regular follow-up of patients.

WALTER M. LEVITT, M.B., D.M.R.E.

## X-RAY TREATMENT OF BONE METASTASIS<sup>1</sup>

By CASSIE B. ROSE, M D, Presbyterian Hospital, CHICAGO

ALL investigators agree that the best treatment of malignancy now known is early and complete removal when this is possible. Since this is, every so often, impossible, many other methods of treatment have been devised. Of all the therapeutic measures, other than surgery, which have been tried, such as caustic pastes, active cautery, various sera, etc., radiation in the form of X-ray and radium

mental and physical. Radiation surely gives relief from pain, together with hope and mental comfort to many of these unfortunate sufferers, ever increasing in number, even though it may not produce permanent cures

In 1916, Pfahler, of Philadelphia (2), first reported cases in which, following radiation therapy, bone destroyed by metastatic carcinoma recalcified, with corre-



Figs 1-A, 1-B, 1-C and 1-D Case 1 Metastasis in the head of the humerus from breast carcinoma, showing progressive evidence of calcification

has taken an outstanding place and seems to offer the most hope. It has proved so efficacious in skin cancer that it effects real cures in more than 90 per cent of the cases, when given fairly early and in sufficient dosage. The cure of deep-seated cancers by radiation has not yet been solved. The combination of radiation with surgery gives from 25 to 30 per cent better results in all types of cases than surgery alone, according to the statistics of various clinics (1)

Medicine should *relieve suffering*, both

sponding clinical improvement. A few similar cases have been reported since.

I believe it is well to re-emphasize this effect of radiation.

My experience with metastatic carcinoma in bone either from breast, prostate, or other source, includes 50 cases. In analyzing the results, I have satisfied myself that, although this treatment does not cure, it prolongs life and relieves the sufferers of their pain to a surprising extent and often makes them able to enjoy life and participate in the activities of their home or even their business to such an extent that they feel the X-ray treatment has put them on

<sup>1</sup>Read before the Radiological Society of North America at the Sixteenth Annual Meeting, at Los Angeles, Dec 1-5, 1930



Fig 2 Case 1. Multiple metastases in many bones

their feet again. Out of this group of 50 cases I want to present to you a few as examples. All of these patients were in the Presbyterian Hospital, Chicago.

#### CASE REPORTS

Case 1. Mrs. G. T. was referred by Dr. D. B. Phemister. Tuberculous glands of the neck had been removed when the patient was 17 years of age, and again when she



Fig 3 Case 1. A pathologic fracture in the humerus, just below the old area of sclerosis

was 21 years old. When she was 36 years old her right breast was removed for carcinoma, proved microscopically. Six years later, that is, in 1924, she complained of severe pain in the left shoulder, at which time



Fig. 4. Case 2. Destruction in the left scapula, said to be a rare site for bone metastasis

X-ray examination showed destruction of the head of the humerus, undoubtedly a metastasis (Fig. 1-A). After two months of X-ray treatment, a film showed evidence of calcification. Subsequent films showed rapidly increasing sclerosis in the involved area (Figs. 1-B and 1-C). The patient's pain disappeared and she was able to use her arm normally, for instance, she could drive her car, can fruit, and sweep the floor.

Two and one-half years later, February, 1927, a roentgen film and clinical examination showed persistence of this good result (Fig 1-D). In the Summer of 1927, while on an extended trip, the patient became lame and suffered from fleeting pains in various

parts of the body. Films taken in October showed multiple metastases to many bones (Fig. 2). Further X-ray treatment effected some recalcification, but never as marked as in the humerus and later some of it disap-

peared again. freedom from pain instead of severe disability.

Case 2. Mrs. H. S. was referred to me for X-ray treatment in November, 1927, by Dr. H. L. Kretschmer. Two years after

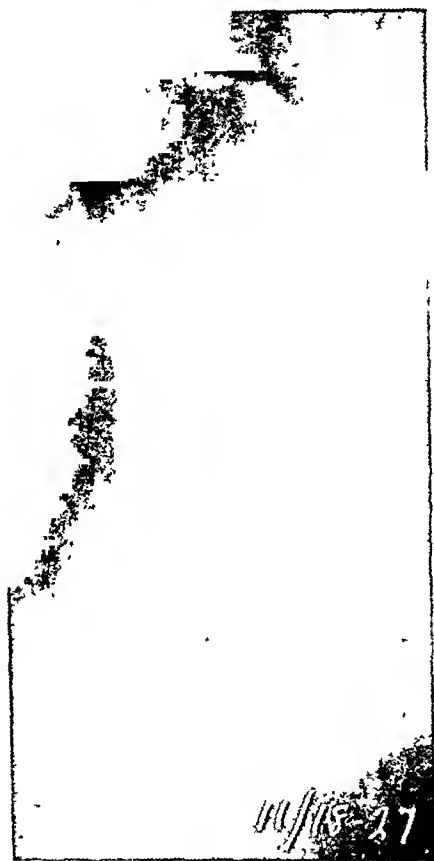


Fig. 5 Case 2 Right ilium, showing metastasis.



Fig. 6. Bone repair in Case 2.

peared again. A pathologic fracture occurred in the humerus, just below the old area of sclerosis (Fig. 3). Although the patient was for the most part fairly comfortable, slept well, and retained her appetite, she went gradually downhill and died in February, 1929,—eleven years after her breast removal and four and one-half years after the bone metastasis was found in the left humerus. It would seem that the X-ray treatment during these four and a half years gave usefulness and comfort and

breast removal, severe pain appeared in the left shoulder and X-ray examination showed destruction in the left scapula (Fig. 4), said to be a rare site for bone metastasis (3). In addition, the third lumbar and the right ilium showed metastasis (Fig. 5).

Bone repair occurred with fair rapidity, with corresponding improvement in clinical symptoms (Figs. 6, 7). During 1928 she was comfortable and able to look after her home and children. Recurrence, with loss of calcification and extension of the previ-

ously involved areas, occurred in 1929 (Fig. 8), with death in September of that year, two and a half years after the metastasis was discovered, and two years after X-ray therapy was instituted. During this time she was greatly relieved of her suffering, due, so far as I can see, to X-ray therapy.



Fig. 7. Bone repair in Case 2.



Fig. 9. Case 3. Partial collapse of the last three dorsal vertebrae, particularly the eleventh, and a fracture of the eleventh rib on the left, close to its articulation with the spine.

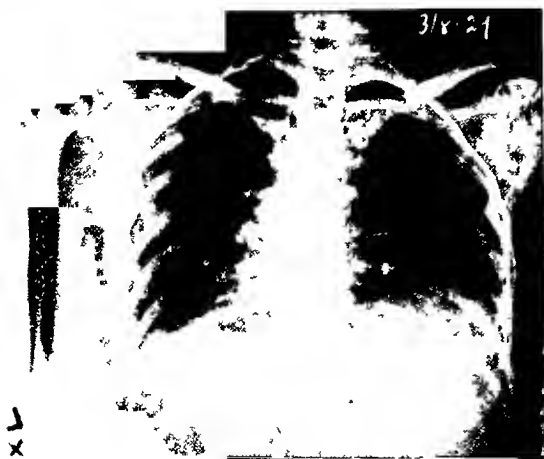


Fig. 8. Case 2. Recurrence, with loss of calcification and extension.

Case 3. The patient, Miss J. B., in December, 1913, five years after she had first noticed a bean-sized nodule in the right breast, had a radical resection done by Dr. A. D. Bevan, for carcinoma (proved microscopically). The nodule at this time was the size of an egg, and the axillary glands were involved. A few X-ray treatments were given post-operatively.

Ten years later, in 1923, the patient noticed a small nodule in the left breast. This grew in two years to the size of an English

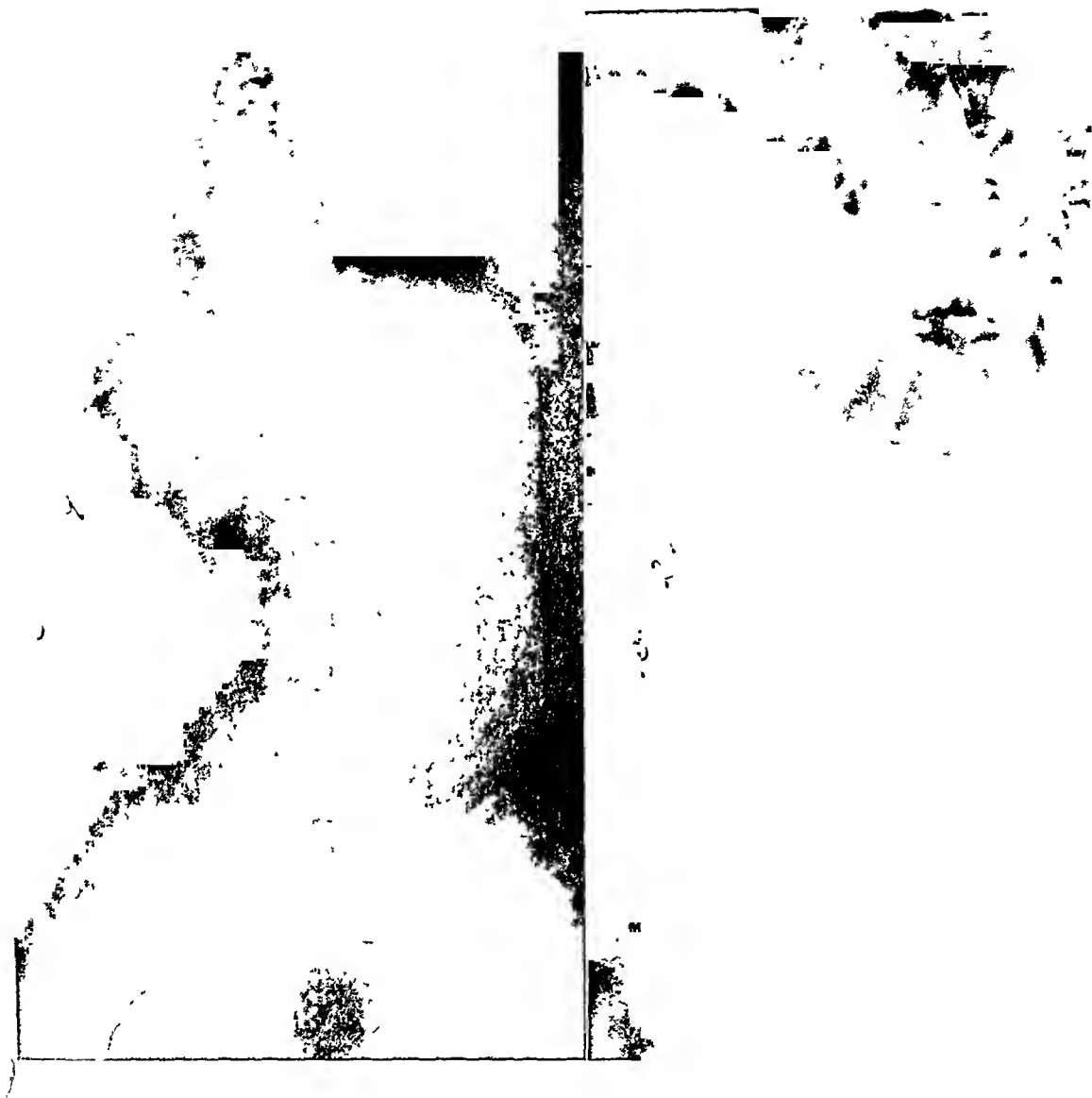


Fig 10 Case 3 Following X-ray treatment, there was some increase in the density of the vertebræ

walnut. In May, 1925, a radical resection of the left breast was done by Dr. Gatewood, and at the same time a recurrence in the right scar was removed. Again X-ray treatments were given, followed by a second series in 1926. In October, 1927, and June, 1928, a dime-sized recurrence appeared in the right scar, and each time disappeared following a short course of radiation. In January, 1929, this area again appeared and ulcerated and neither X-ray nor radium sufficed to close it entirely. In

June, 1929, the patient developed pain in the legs, with difficulty in walking. In August an X-ray film (Fig. 9) disclosed partial collapse of the last three dorsal vertebræ, particularly the eleventh, and a fracture of the eleventh rib on the left, close to its articulation with the spine. After X-ray treatment the pain disappeared and films (Fig. 10) showed some increase in the density of these vertebræ. The patient returned to her work, but a month later the pain recurred, she became progressively

3/24-30



Fig 11. Case 3. Autopsy specimens.

weaker, was confined to bed, but was fairly comfortable under mild sedatives. She died in April, 1930, twenty-two years after she had first noticed a nodule in her breast. A definite, although short, relief from pain and disability in walking was obtained through X-ray therapy, and there was some reformation of bone tissue.

Postmortem (Fig. 11) showed pathologic fracture of both femurs and carcinomatous involvement of the spine, together with multiple miliary metastases in many parts of the body. Microscopically, small spicules and buds of new bone were visible in the previously collapsed and radiated dorsal vertebræ. It is impossible to state whether this new bone was the result of X-ray therapy, or simply callus following fracture. In three other patients with similar metastatic involvement, who did not have X-ray therapy, such bone buds were not seen. Further study of postmortem evidence is needed.

Case 4. Mrs C. D. was a patient of Dr. W. E. Post. Two years subsequent to the removal of the left breast, this patient, aged 36, delivered a full-term baby. In the latter



Fig 12 Case 4. Bone destruction

part of the pregnancy she complained of much pain in the pelvis and legs and was unable to walk. This was interpreted as pressure pain. However, it did not dis-



Fig 13 Case 4 Calcification in areas of bone destruction





Fig. 14. Case 4. Evidence of calcification.

appear after the delivery but grew progressively worse. The patient became unable to turn in bed without help, and then only with excruciating pain. Opiates gave only partial relief.

X-ray films (Fig. 12) taken in July, 1928, showed bone destruction of the left side of the sacrum, the right acetabulum, the third, eighth, eleventh, and twelfth dorsals, and first lumbar, also complete erosion with fracture of the seventh and eleventh ribs and many other small areas of rib involvement. In August, 1928, the patient was referred to me for X-ray therapy. Rapid relief of pain and calcification in the areas of bone destruction followed. In October she was comfortable; in March, 1929 (Figs. 13, 14), she was walking with a cane; a few weeks later the cane was discarded, and she was able to live her normal life. In January, 1930, she took a seventy-mile automobile ride without discomfort. Films at this time showed such complete regeneration of bone that the old areas of destruction were difficult to visualize.

However, carcinoma developed in the other breast, and numerous firm nodules appeared in the skin of the neck and abdomen.

Films (Figs. 15, 16, 17, 18) showed evidence of metastases to the bones of the skull, and the areas previously involved became a little less densely sclerosed, although the destruction was not nearly so marked as on the first films of this patient. In July she still was able to walk, though with less agility, and considerable nausea and vomiting had developed. On October 28, 1930, she died. During this time never more than four aspirin tablets in twenty-four hours were needed to control her pain, and on some days none were needed. No morphine was given except one dose the day before her death. At no time did she lose her morale. She had two full years of comfortable and useful life, instead of being bedridden and tortured with excessive pain, and I believe that the X-ray should be credited with this good result. Autopsy was not permitted.

Case 5. Mr. F. H. was a patient of Dr. H. L. Kretschmer. He was a man 74 years of age, who entered the hospital in March, 1927, complaining of prostatic symptoms of four or five years' duration and recent pain in the right leg, with difficulty in walking. A large hard nodular prostate was found. X-ray films taken in March, 1927 (Fig. 19), showed extensive destructive metastasis to the right side of the pelvis. A suprapubic cystotomy was done and X-ray therapy was started. Within two months the pain had disappeared and the patient went home. He returned six months later (in December, 1927), with recurrence of pain in the right leg. X-ray films (Fig. 20) showed some—not very marked—increased calcification in the previously involved area. Further X-ray treatment was given. Following this for a year the patient was perfectly comfortable and able to carry on his usual work, which involved many long motor rides. In December, 1928, he returned with pain in the left leg, but no pain had recurred in the right leg. A series of X-ray treatments re-



Figs 15 and 16 Case 4. The areas previously calcified are less densely sclerosed

lieved the pain. A film at the end of the treatment (Jan. 3, 1929) showed a heavy calcification in the right side, and numerous rounded areas of increased density in the left side of the pelvis (Fig. 21). Again he went home comfortable, but died some three or four months later. I believe the X-ray treatment gave to this man more than a year of comfortable, active business life which he would not otherwise have had.

Case 6. Dr. F. B., a patient of Dr. A. H. Montgomery, aged 61, was diagnosed in June, 1928, as having carcinoma of the prostate. Radium was given through the

perineum four times. In August, 1929 (Fig. 22), an X-ray film showed multiple small rounded areas of faintly increased density throughout the bony pelvis. At the same time the patient was in severe pain—unable to turn in bed without help and then only with great difficulty. Opiates were not tolerated. Pantopon was tolerated fairly well and gave some relief. X-ray treatment was started. Within two months the patient was able to walk up and down the corridor of the hospital. A film (Fig. 23) showed a marked increase in the density of the small rounded areas seen on a previ-



Figs. 17 and 18 Case 4 Evidence of metastases to the bones of the skull.

ous film of the pelvis. A film in December showed still further sclerosis of these areas (Fig. 24). The patient was able to go home but returned in March with a nephritis of severe degree, which terminated in uremia in April. The severe bone pain did

not return to any considerable degree. Subsequent films were not taken and autopsy was not permitted. I believe that the X-ray therapy gave this patient definite and

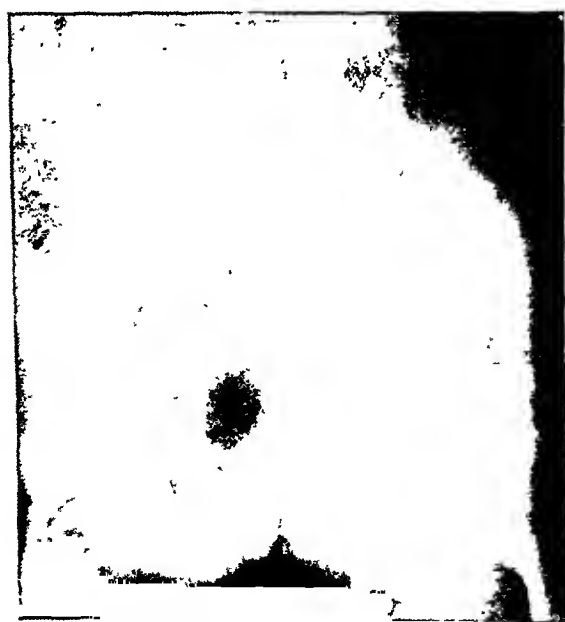


Fig. 19. Case 5. Extensive destructive metastasis to the right side of the pelvis



Fig. 20. Case 5. Some—not very marked—increased calcification in the previously involved area.



Fig. 21. Case 5. Film taken at the end of the treatment, showing a heavy calcification in the right side, and numerous rounded areas of increased density in the left side of the pelvis.

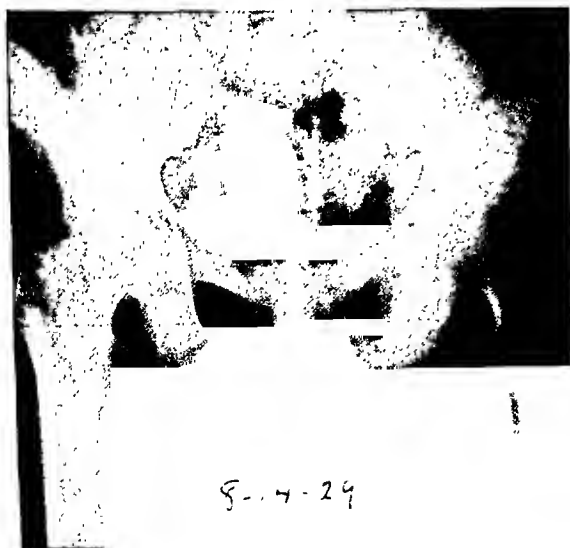


Fig. 22. Case 6. Multiple small rounded areas of faintly increased density throughout the bony pelvis.

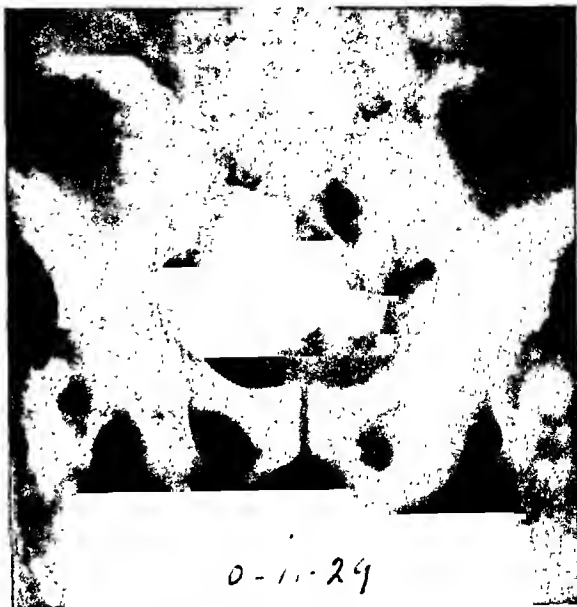


Fig. 23. Case 6. Marked increase in density of the small rounded areas seen in Figure 22.

very welcome relief from the pain, which he was unable to get from medication.

For all of these patients I have used a routine treatment dose: 140 kilovolts, peak; 5 milliamperes; 10-inch skin target distance;  $\frac{1}{4}$  mm. copper and 1 mm. aluminum filter; time, 10 minutes, covering an area 15 cm. in diameter. This dosage gives 35 r per minute. One area was radiated at each treatment, rarely two areas. Treatments were given, as a rule, two or three times per week, and were directed from various angles toward the areas of involvement. I did not treat the same area oftener than once in ten days or two weeks. Treatment was continued for a period of from four to six weeks, after which the patient was given a rest interval of from one to two months. After the patient became comfortable radiation was intermittent or even discontinued for several months. In one or two instances in which the patient came from a considerable distance, treatments were given daily for a period of two or three weeks.

Glucose, either intravenously or orally, usually in conjunction with calcium lactate,



Fig. 24. Case 6 Still further sclerosis of the areas shown in the previous figures.

was given to several of these patients for varying periods of time. In some instances it seemed to help, though I was never sure that it was of any considerable value therapeutically. If long continued, the patients developed a strong aversion to it. In the case with metastasis to the humerus, the patient was treated without glucose until the time of the late generalized metastases.

I am of the opinion that frequently repeated doses of X-ray of moderate voltage are sufficient, and, in the long run, give satisfactory results. In my experience comparatively little roentgen sickness has appeared.

Because clinicians in general and many roentgenologists seem to feel that when bone metastases occur the case is utterly hopeless, I am presenting these six cases as a plea that these patients be given the benefit of radiation therapy. This relief of suffering and the reformation of bone are the two factors which should make us look

upon X-ray treatment as the greatest boon to the patient until medicine shall have found a cure for this disease, a part of which may be X-ray.

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#### DISCUSSION

DR. FRANCIS CARTER WOOD (New York City): I think Dr. Rose's paper is an excellent illustration of the purely palliative type of treatment with which we are all familiar. I think she has well stressed the very important point not to use high voltage radiation, which makes these patients very sick and does not improve the lesion any more than does the use of a moderate voltage, which is easily handled and is at everyone's disposal. The cases which I have seen treated with high voltage have usually done badly. My own practice is about that of Dr. Rose, repeated low voltage treatments giving about 60 or 70 per cent of an erythema or some 400 r units. I can, of course, only agree with her that many of these cases do extremely well; patients are able to get back to work and are freed from the necessity of taking drugs, and a little aspirin or a similar sedative will often carry them along to within a few weeks of their death. It is rather interesting to note that these patients who get bone metastasis rarely get pulmonary lesions; the ones that get pulmonary lesions die early and we can do little for them. The trouble is we rarely get these patients until the bones are invaded, and after some practitioner has

treated the patient for rheumatism, and thus time is lost. Such patients should be turned over to the radiologist, given light doses of X-ray over the lesion to prevent skin recurrences, and kept under observation. Radiation should be begun before bone changes are shown. The bone change is late and means absorption of calcium salts, but many patients have their bone pains early, and,

if treatment is begun then, we get a much more satisfactory prolongation of life. The surgical profession is by no means aware of the fact, nor is the general practitioner, that a great deal can be done in the prolongation of life—two or three or four or five years—with a minimum amount of treatment, and of a type which does not annoy the patient.

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Sunlight and Vitamin D. A. v. Wijk, E. H. Reerink, and W. Mörikofer. *Strahlentherapie*, 1930, XXXIX, 80.

In previous investigations, the authors studied qualitatively the absorption spectrum of the products formed in irradiated ergosterol. They were able to determine the composition of an irradiated ergosterol solution from the absorption spectrum. The application of these results for a comparison of therapeutic lamps, suggested itself. It was necessary only to compare the amounts of Vitamin D produced in an ergosterol solution following exposure to various light sources. On that basis, the sun and a quartz mercury vapor lamp were

studied. As a measuring instrument between 2,900 Ångströms and 3,100 Ångströms, the authors chose a cadmium photo-electric cell. In the solution exposed to sunlight, the Vitamin D was destroyed much quicker, and a secondary decomposition product appeared. Although it is not possible to compare the effects of the two light sources, expressed in identical units of energy, the authors state that the ratio between vitamin destruction and vitamin production in an irradiated ergosterol solution was from 0.137 (for the quartz mercury vapor lamp) to 0.34 (for the sun).

ERNST A. POHLE, M.D., Ph.D.

# MALIGNANT TUMOR OF THE ETHMOID<sup>1</sup>

By J. E. HABBE, M.D., MILWAUKEE, WISCONSIN

**I**N a paper before the Radiological Society of North America at Toronto,

December, 1929, on the treatment of malignant tumors of the nasal accessory sinuses, Douglas Quick, of the Memorial Hospital, New York City, said: "It has been our unfortunate experience that radiographs for diagnostic purposes have not been as valuable as one might ordinarily expect, except in the very late stages where the differentiation is obvious to other and simpler

help in 90 per cent of these cases of carcinoma involving the accessory sinuses."

The writer's personal experience in tumors involving the accessory sinuses has been too limited to warrant any statement as to the percentage of accuracy of the X-ray diagnosis of this condition. This single case is presented, however, as one in which the X-ray signs of malignancy were present some six or seven weeks prior to definite clinical findings.



Fig 1 Erosion of right lamina papyracea indicated by arrow. Seven weeks prior to possible clinical evidence of tumor

means of examination. We feel that diagnostic X-rays have been of real value in only about 5 per cent of the cases "

In a discussion of this article, however, Pfahler said: "I believe that we should get

## CASE REPORT

A man, aged 38, was referred for X-ray examination November 25, 1929, because of pain of recent origin in the right eye and temple. The patient also had some dullness in the head and a strained feeling in the

<sup>1</sup>Read at the mid year meeting, Radiological Section, Wisconsin State Medical Society, May 23-24, 1930, Green Bay, Wisconsin

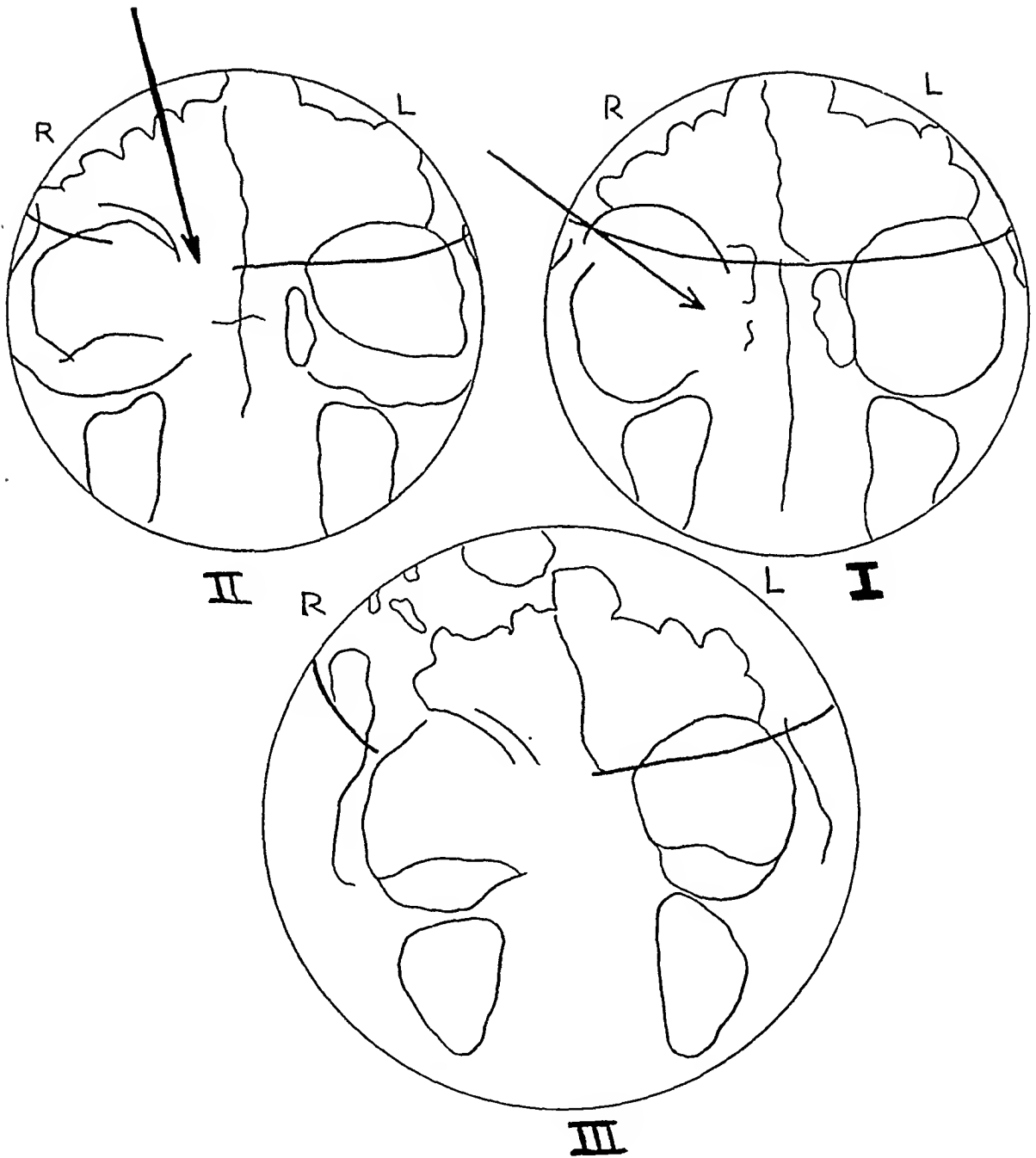


Fig. 2. Diagrammatic sketch showing (I) erosion of right lamina papyracea at first examination; (II) appearance seven weeks later, with additional destruction of right cribriform plate and portion of floor of anterior fossa; (III) final appearance following exploration and radium insertion into tumor-bearing area, one month prior to death.

eye, which symptoms were relieved by aspirin. A recent change in glasses had also given considerable relief. Rhinoscopy was

essentially negative, but transillumination of the right frontal sinus and right antrum showed slight haziness, and by ophthal-



R

L



Fig. 3. Granger projection, showing marked right ethmoid clouding.

not remarkable, there having been occasional colds, and change of glasses—as might be in the past history of anyone, at the given age and in this climate.

On the day of the first X-ray study the clinician stated that there seemed to be a slight increase in ocular tension of the right eye, but there was no nystagmus or double vision.

The essential X-ray findings at this time were a slight diffuse clouding over the right ethmoid region, with loss of much of the bony detail of the cell trabeculae and a portion of the medial orbital margin (that portion made up by lamina papyracea). The blotting out of the medial orbital margin shadow was best shown on the Caldwell film, the evidence of the ethmoid pathology was confirmed by the Granger projection.



Fig. 4. Intra-oral film showing right ethmoid clouding, with disappearance of ethmoid-cell trabeculae, especially in posterior ethmoid region. (Symmetrical appearance of ethmoids on intra-oral film shown on right)

moscopic examination the discs were slightly hyperemic but were equally so on both sides and the margins were quite clear.

The past eye, ear, and nose history was

and the destruction of the ethmoid cell trabeculae was most clearly shown on an intra-oral film taken with a Hayden cassette. Each of these three views was of distinct value

in arriving at a diagnosis of malignant disease involving the right ethmoid region.

The patient was seen in consultation by other clinicians, but the X-ray impression could not be clinically confirmed.

of a therapeutic test, for the patient suffered a moderately severe reaction in the way of marked increase in pain and repeated vomiting for a period of two or three days thereafter.



Fig. 5. Showing additional destruction of right cribriform plate at time of development of positive clinical signs of malignant tumor.

The question of X-ray therapy came up, but, following the recommendation of Sosman that roentgenotherapy in any case of intracranial tumor must be given with caution and rarely administered before an attempt has been made to extirpate or at least do a decompression, the advice was against therapy. However, because of increasing headaches and eye pain, a small dose, using a portal one inch in diameter, over the right ethmoid region anteriorly, was given on December 7, 1929, employing the following factors: 130,000 peak volts, 40 ma.-min., 12-inch distance, filter of  $\frac{1}{4}$  mm. copper and 1 mm. aluminum (well under 25 per cent skin erythema in view of the small portal).

From the roentgenologic standpoint, the single X-ray treatment served as something

Within a few days of the treatment the patient had sufficiently improved from his reaction to warrant his travelling to another city, where he underwent a general study for some days, but again the original diagnosis of tumor could not be substantiated and treatment was outlined on the assumption that the patient's symptoms were in the nature of a sphenopalatine ganglion neuralgia.

He returned to his home and made some effort to resume his business but the pain and headache gradually increased and on January 13, 1930, when referred again for X-ray study (just seven weeks following the date of the original sinus X-rays), the clinician reported that the patient showed, for the first time, unilateral exophthalmos,

loss of central vision, and a bulging into the ethmoid region of the right nose. The X-ray findings at this examination were def-

found, and multiple areas of destruction in the right frontal bone were also shown, which were attributed entirely to tumor ex-



Fig 6 Final examination following exploration and radium therapy. Death one month later

inite increase in bone destruction as manifested by a disappearance of the line representing the right cribriform plate.

A radical trans-frontal exploration of the right ethmoid region was made and tumor involvement of the ethmoid labyrinth was found, the microscopic diagnosis being epithelioma graded three. The origin of the tumor could not be determined. Radium was inserted into the operative wound and left sufficiently long to give an intensive dose of filtered rays.

Again the patient returned to his home and again made some final effort to resume his business, but the pain became worse and the vision was lost in the affected eye.

Final X-ray studies were made on March 28, at which time even more extensive destruction of the right orbital margin was

tension, although undoubtedly the evidences of right frontal and maxillary sinusitis may have been in some part an evidence of radium reaction.

The patient died April 27, 1930, just five months after the first definite diagnosis of malignant tumor had been made.

#### CONCLUSION

A case of epithelioma involving the right ethmoid region is reported, in which definite X-ray evidence of an invasive lesion, with destruction of the ethmoid cell trabeculae and the lamina papyracea, was demonstrated some seven weeks prior to positive clinical signs of tumor. The tumor grew rapidly despite intensive radium irradiation from within it, and death ensued

within five months of the time the original diagnosis of tumor was made.

The author wishes to thank Dr. H. G. Martin and Dr. T. L. Tolan for kindly supplying the clinical findings, and Mr. Leo Massopust, Marquette Medical School artist, for the reproductions and diagrammatic sketches.

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The Relation between Division Rate and the Radiosensitivity of Cells. Charles Packard. *Jour. Cancer Research*, August, 1930, XIV, 359.

The author irradiated *Drosophila* eggs whose rate of cell division can be controlled by temperature. The eggs had been kept at the desired temperature for thirty minutes or more before radiating and during radiation. The temperatures employed were 13°, 23°, and 28° centigrade. The dose of X-rays in each instance was 150 K.V., 5 ma., at 40 cm. distance. Measurements showed that the intensity of the beam falling on the eggs was 17.0 r-min., including the scatter from the water and the walls of the chamber. The filtration was 0.25 mm. of copper and 1.0 mm. of aluminum. After 5, 10, 15, and 20 minutes of radiation, samples were removed and incubated in a moist chamber at room tempera-

ture. The percentage of eggs which hatched was considered an index of the effect. The author concluded that susceptibility rises as the rate of division at the time of exposure increased. The two curves, however, are not parallel.

*Drosophila* eggs were irradiated at room temperature and immediately afterward divided into two lots, one incubated at 18° and the other at 28° centigrade. The sensitivity of the chilled eggs was 89 per cent of that of the eggs reared at room temperature; the sensitivity of the warmed eggs was 110 per cent. This difference exceeds by far the limits of ordinary variation.

The author concluded that the activity of cells after exposure is also a factor in determining the ultimate injury sustained. The effect is lessened when the activity is decreased.

JOHN R. CARTY, M.D.

# CASE REPORTS AND NEW DEVICES

## HEAD CLAMPS FOR A FENESTRATED SHIELD FOR ROENTGENOGRAPHY OF THE NASAL ACCESSORY SINUSES

By MRS. J. D. BLOCHER

Section on Roentgenology, The Mayo Clinic  
ROCHESTER, MINNESOTA

An improvement has been made on the fenestrated shield described in *RADIOLOGY*, February, 1928, X, 163. The shield presented here consists of a lead plate 1.15 mm. thick, faced on each side with a sheet of brass 0.4 mm. thick, making a composite plate with a total thickness of 1.95 millimeters. The mask is large enough to cover an 8 by 10 cassette exactly, and has a flanged edge to prevent any displacement. Two disks have been cut out of the mask, leaving two circular apertures, spaced 12 cm. center to center. These disks fit the openings in the mask exactly, one being kept

in place while an exposure is being made through the opposite side. Each disk has a rivet soldered in the center to facilitate handling.

The improvement comprises two metal wings adjustable on a common sleeve, which, in turn, is mortised and movable on a square bar. The ends of the square bar are secured in the upper ends of two brackets permanently fastened to the shield. The metal wings extend 15.2 cm. from their supporting hubs, broadening from a width of 3.17 cm. at the hub to 6.03 cm. at the outer ends. They are 1.58 cm. thick, with edges and corners rounded. The hubs are fitted to slide easily for adjustment over the sleeve and are anchored in position by thumb screws.

The cylindrical shape of the sleeve permits the wings to be moved vertically and fastened in position as desired. The sleeve slides easily for lateral adjustment and is held in position by a thumb screw fitted into

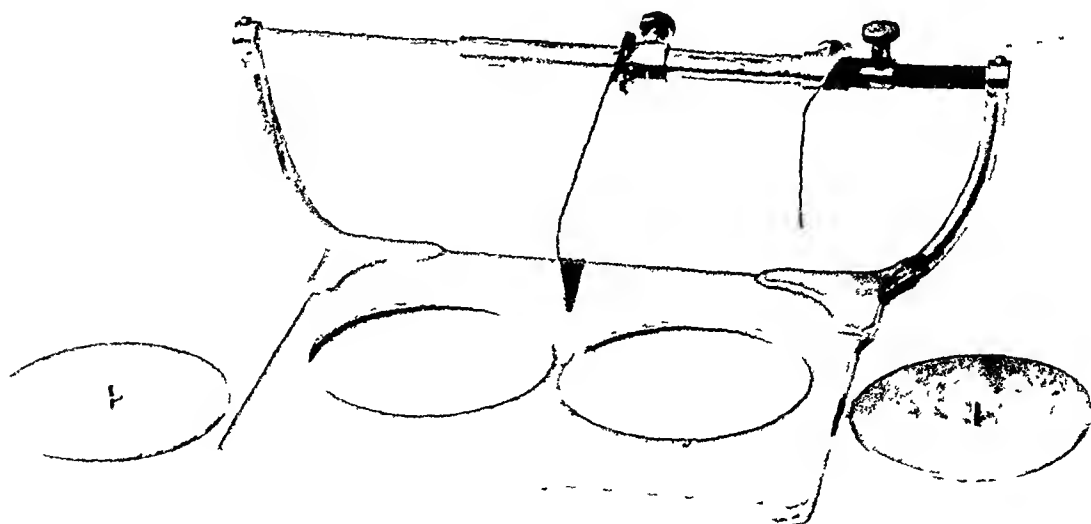


Fig 1. The mask, with disks and head clamp.

one end. The fact that the square bar is stationary and is permanently secured to the two brackets, permits the sleeve and wings to be easily located and fastened in proper position. The brackets extend at  $45^\circ$  outward 6.98 cm from, and 8.89 cm. above,

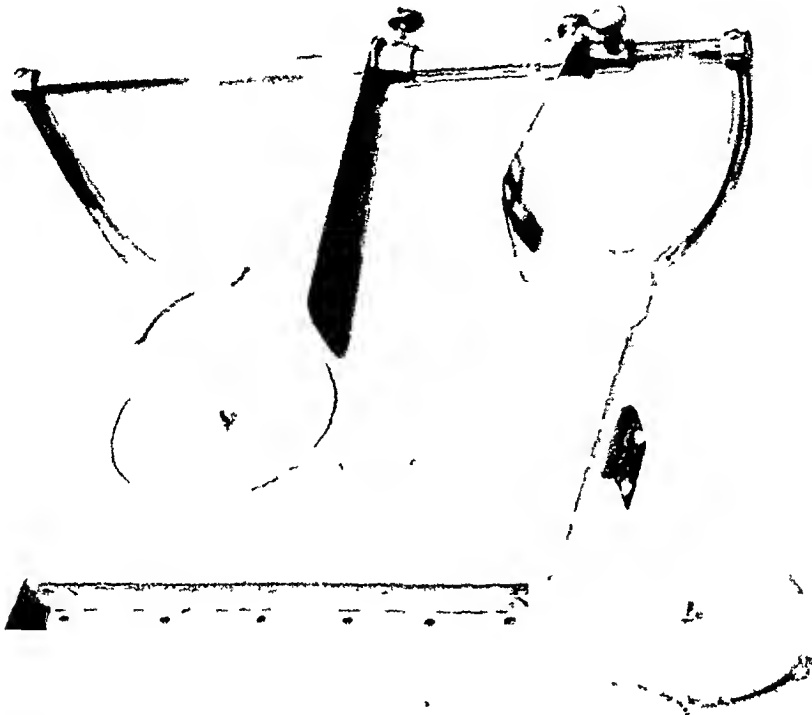


Fig 2 The cassette, covered with the mask, placed on sinus board



Fig 3 Exposures made by the use of the mask, the nasal sinuses

the top of the shield and are 38.1 cm. apart. The sleeve is of 1.74 cm. outside diameter and is 22.86 cm. long. The wing hubs are

mortise to receive the ends of the bar which are held by a No. 8-32 machine screw in each.



Fig 4. Exposures made by the use of the mask; the mastoid regions.

2.54 cm. long and 2.22 cm in diameter. The bar is 0.952 cm. square in cross-section and 40.64 cm long. The upper ends of the brackets are 1.40 cm in diameter and 1.27 cm. long, each having a 0.952 cm. square

Although this instrument was devised previously for roentgenography of the nasal sinuses, it has been found of equal utility in the making of roentgenograms of the mastoid regions.

## REPORT OF A PATIENT WITH EWING'S SARCOMA<sup>1</sup>

By E ERIC LARSON, M.D.,  
LOS ANGELES, CALIFORNIA

The patient, Mrs. H. B. P., aged 23, employed as a cashier, married six months, was seen Oct. 17, 1930. Her complaint was that of constant boring pain in the upper part of the left femur, with marked swelling, and progressive loss of weight.

She stated that eleven weeks previous to this initial examination, after a game of tennis, she felt that a lumbar vertebra was out of place. This was adjusted by an osteopath who, at the third and last treatment, gave her legs a vicious jerk. Two days later

the patient noted pain in the upper portion of the femur, with a noticeable swelling anteriorly. Her physician found a slight fever, but could not ascertain the cause of her trouble. After the patient had taken medicine for a time the pain disappeared, but the swelling progressed. Two months later, after a horseback ride, the pain recurred and persisted. At this time the blood count was normal. X-ray examination of the left femur and thigh was reported negative. The patient spent three weeks in bed, complaining of pain, tenderness, and progressive enlargement of the tumor, with slight fever; then she consulted us for an opinion as to the cause of her distress and suggestions for relief.

Physical examination revealed a slender young woman, weighing ninety-five pounds,

<sup>1</sup>Presented before the Radiological Society of North America, at the Sixteenth Annual Meeting, at Los Angeles, Dec 5, 1930



Fig. 1. X-ray film taken Nov. 5, 1930, shows suspicious defect in the upper portion of the femur. In the soft tissues around this defect can be seen a shadow of the tumor.



Fig. 2. X-ray film taken Nov. 19, 1930, definitely reveals the defect in the upper portion of the femur. It has also increased in size and has the appearance of an osteomyelitis.

who said that she had had a loss of fifteen pounds during the past eleven weeks. She was pale and looked ill. The left thigh was quite swollen, with no apparent demarcation of the tumor. The mass appeared to be semi-solid in consistency, with a generalized tenderness over the whole area of swelling.

Blood analysis revealed 4,400,000 erythrocytes and hemoglobin of 12.5 gms. (72.6 Sahli); 9,100 leukocytes differentiated as neutrophils 53 per cent; eosinophils 1 per cent; large lymphocytes 44 per cent; mononuclears 1 per cent. The coagulation time was four minutes. The blood Wassermann was negative.

X-ray examination of the left femur revealed a very slightly suggestive lesion in its upper third. No definite diagnosis could be made from the X-ray studies (Fig. 1).

A diagnosis of hematoma, osteomyelitis, or sarcoma was made and exploration ad-

vised. Accordingly, on Oct. 21, 1930, the anterior aspect of the thigh was opened, just over Scarpa's triangle. By blunt dissection down to the periosteum there was encountered near the bone what appeared to be an organizing blood clot about 5 cm. in diameter. This was carefully swabbed out and, since no other mass could be felt and the periosteum seemed intact, we were of the opinion that we were dealing with a hematoma. The wound was closed, a rubber drain inserted which was removed on the fourth day, followed by prompt healing. The blood clot was cultured and also examined under the microscope, and was reported negative.

On Nov. 20, 1930, because of increased swelling and pain, it was found necessary again to explore the thigh. The X-ray examination showed that the original defect in the femur had become larger in extent and



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Physical examination revealed a slender young woman, weighing ninety-five pounds,

<sup>1</sup>Presented before the Radiological Society of North America, at the Sixteenth Annual Meeting, at Los Angeles, Dec. 5, 1930.

the diagram, Figure 1, shows, it consists essentially of a gang switch of special design, bolted inside the control cabinet of the

just as if the switch were not there. When the switch is pulled to the left, No. 2 is disconnected from No. 3 and connected to No.

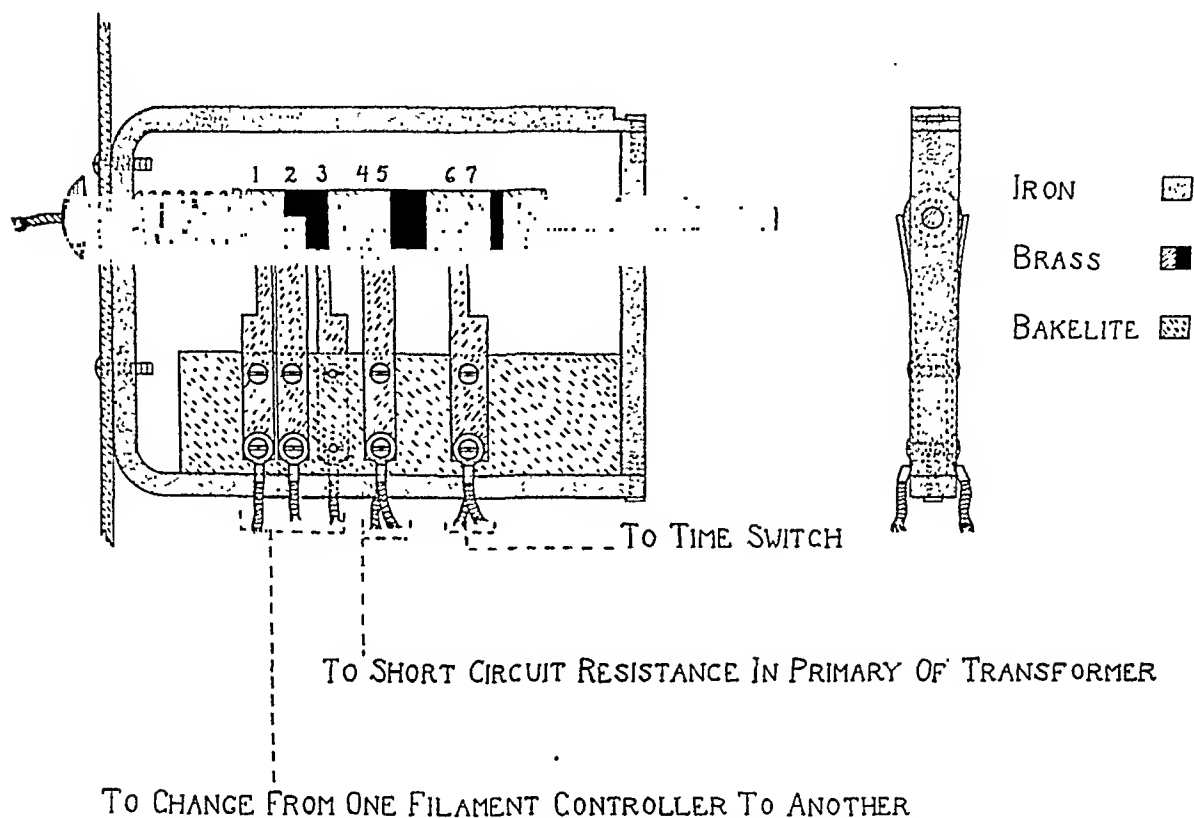


Fig. 1. Drawing of the switch in the fluoroscopic position. The instrument is mounted inside the control cabinet of the X-ray machine and the knob on the left extends through the side of the cabinet. It is operated by a pull on the cord, and is returned to the fluoroscopic position after the pull is released, by the coil spring.

X-ray machine, and is operated by a pull cord fastened to the handle which projects through the side of the cabinet. The three brass rings are all mounted on a bakelite rod and insulated from each other and from the central shaft. Spring brass brushes are so arranged that they make contact with the rings when the switch is pulled into active position.

The diagram shows the switch in the fluoroscopic position where Brush No. 2 is connected electrically with No. 3, these two being connected in series with the filament controller on the X-ray machine. This allows the current to flow to the controller

1, cutting in another filament controller which has been set up to the desired milliamperage. Thus the problem of milliamperage is met. A wire-wound rheostat answers the purpose well for this extra controller.

Brushes No. 4 and No. 5 are connected together electrically when the switch moves to the left and short the resistance in the primary of the transformer. This has the effect of changing from the "Limited" to the "Full" capacity on the KK disc rectifier machine. On a machine of other make it would be used to short that part of the resistance which was used for fluoroscopy.

Brushes No. 6 and No. 7, when closed, set up the time switch. While this instrument is intended to be used in conjunction

It is to be noted that while the brushes for the timer and filament controller are small, the ones that short the resistance



Fig. 2. Showing how the pull cord is used by the left hand of the operator, as he stands at the fluoroscope.

with the author's timer (1), it could be made to set up any one of the motor-driven timers by turning on the current to the motor.

The exposure is made with the foot switch while the operator holds the cord in his left hand, as shown in Figure 2.

should be large enough to carry about 50 amperes.

This instrument has been in steady use for over four years, needing no attention except an occasional drop of oil.

#### REFERENCE

TAFT, ROBERT B.: Time Switch of Unusual Design.  
RADIOLOGY, November, 1930, XV, 592.

# EDITORIAL

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M. J. HUBENY, M.D. . . . . *Editor*  
BENJAMIN H. ORNDORFF, M.D. . . . . *Associate Editor*

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## THE RÔLE OF RADIOGRAPHY IN MATERNITY CARE

A distinctly modern phase of obstetric practice is the comprehensive care of the mother during pregnancy and after labor has been accomplished, especially the former. Obstetrics, it is being realized more and more, comprises much more than the mere delivery of the child. The prophylaxis of disease and of abnormal presentational complications has become a very important part of the duties of the obstetrician; and this prenatal care of pregnant women is now insisted upon in private practice as well as in the prenatal clinics for the poorer classes of women that have sprung up all over the country.

Our attention has been called recently to this subject by the illuminating report of the Maternity Center Association and the Statistical Bureau of the Metropolitan Life Insurance Company, of New York. The records presented by these organizations cover 4,726 women who were cared for during the eight years, 1922-1929, inclusive. Very striking results were obtained by this prenatal management, including a reduction of the maternal mortality to about a third of that obtaining among women not receiving the prenatal attention; a reduction of infant deaths in the first month of life of 32 per cent, as compared with the control group in

the same metropolitan area, and a record of stillbirths 42 per cent lower than that occurring among women not receiving prenatal care.

No woman under this care died before delivery during the entire eight years; and only 11 mothers died from puerperal causes, a rate equivalent to but one puerperal death for every 430 pregnancies. The maternal mortality rate based on live births was 2.2 per 1,000, which compares favorably with the rate of 5.3 per 1,000 live births among white women in New York City. In the Bellevue-Yorkville district the mothers who did not have the care of the Maternity Center Association showed a maternal mortality rate of 6.2, or nearly three times as high as the rate for mothers who had that care.

Such results are very convincing, and amply emphasize the value of the care given the women.

It would be interesting to know just what part in this reduction of fetal and maternal morbidity and mortality was played by radiography of the pregnant women. No data are given on this subject in the records published by the investigating bodies. The very short period of exposure required to make roentgenograms of the pelvis and abdomen renders this valuable diagnostic aid absolutely safe; and when one recalls how much information of value may be obtained from these X-ray films, it becomes evident that radiography should hold a prominent place in the prenatal care of pregnant women.

Not only can deformities and contractures of the maternal pelvis be recognized early and appropriate treatment instituted, such as the induction of premature labor or an elective cesarean section, with or without

the test of labor, but fetal abnormalities of development and abnormal positions and presentations may also be noted early and the latter corrected in many instances. We firmly believe that every pregnant woman should be examined by the X-ray at intervals from the fifth month on, as a valuable aid to the obstetrician in noting the progress of the case. The fear that uvular or fetal death or deformity may be so produced may be discarded, for these accidents can occur only from prolonged irradiation in the very early weeks of gestation during the formative period of the embryo.

We believe that all that is necessary is to call the attention of these public welfare bodies to the value of a proposed innovation. Sufficient proof is now available to show that the judicious use of the X-ray in the diagnostic study of pregnancy has been productive of much good, and we can positively conclude that, consequently, the X-ray has become an important prophylactic measure and aid in obstetric diagnosis.

W. A. NEWMAN DORLAND, M.D.

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#### REPORT OF CHAIRMAN OF COMMITTEE ON INSURANCE

*To the officers and members of the Radiological Society of North America, Sixteenth Annual Meeting, at Los Angeles, 1930:*

Your Committee on Insurance begs leave to present the following report:

During the past year several members of the Society have asked the Chairman what was known about certain insuring organizations and agencies, and, because of these inquiries, he has taken upon himself as a duty the investigation of some of these insurers, particularly those not well known to us.

After investigating one of these organizations which offers a rather attractive low

premium rate, he secured the following information.

The — Company, of —, was incorporated several years ago, after certain of the regular malpractice insurance companies notified users of the Abrams Electronic Reactions methods that they must either discontinue using the "ERA" or have their malpractice insurance contract canceled. The — Company in question was organized on the mutual plan, a plan decried by men who know the malpractice insurance business and one which, it has been decided by courts of last resort, will render a member of such organization incompetent as a witness for and in a malpractice suit against any other member of the same organization (Hoover vs. McCormick, Kentucky case). The original board of directors of this Company consisted of three physicians, all "ERA" users, and two osteopaths. In about a year one of the physicians was displaced by an osteopath, whereupon the governing body was composed of three osteopaths and two physicians, and neither of these two latter were members of organized medicine. The Company's literature at that time stated that its organization was by, of, and for electronists, and a little later it made the same statement in regards to being by, of, and for osteopaths.

An abstract from a letter written by one of the officers of this insurance organization about three years ago reads in part: "You will be surprised to know how fast our company is becoming osteopathic in its membership." At that time one of the principal officers of that State's Osteopathic Association was on the directorate of this Company.

The insurance contract issued by this Company has contained several items to which serious exception can and should be taken, and with which serious fault can be found, but as these documents change from time to time some of these objections may have been eliminated.

Although the organization investigated

has been in business considerably over seven years, a recent financial report indicated that its assets amounted to less than \$12,000, and the latest financial report shows its assets as less than \$13,000.

Your Committee also desires to call the attention of members of the Radiological Society to a report of the "Bureau of Investigations" of the American Medical Association, published in the *Journal of the American Medical Association* for December 20, 1930, page 1931, and to suggest that all should read the last paragraph at *least three times*, and then refer to what your Committee on Insurance has repeatedly stated in regard to *mutual insurance companies*.

The Chairman of your Committee on Insurance receives from two to six letters every month relative to malpractice insurance, and answers from two to twenty questions regarding insurance in each letter. He has in preparation a paper covering the subject of malpractice insurance in a thorough manner, which it is hoped will be ready for publication some time within the next three or four months.

In conclusion, the Chairman desires to recommend that this Committee be continued and that this report be published in **RADIOLOGY**.

I. S. TROSTLER, M.D., *Chairman*.

A motion was made, seconded, and unanimously carried that the report be received and the recommendations concurred in.

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## HONORS IN OTHER SOCIETIES

Ulysses S. Kann, M.D., a member of the Society from Binghamton, New York, has been honored with the presidency of the Broome County (New York) Medical Society. Blinn A. Buell, M.D., is Vice-president, Henry D. Watson, M.D., is Secretary, and Charles Pope, M.D., is Treasurer.

Dr. Kann was likewise elected to the presidency of the Central New York Roentgen Ray Society, at the January meeting in Syracuse. Lucas S. Henry, M.D., a member of the Radiological Society of North America from Syracuse, was elected Vice-president, and Robert C. Hall, M.D., a member from Utica, was chosen Secretary and Treasurer of the Central New York Roentgen Ray Society.

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## CANADIAN RADIOLOGISTS FOSTER EDUCATIONAL PROPAGANDA

At the recent joint meeting of the British and Canadian Medical Associations in Winnipeg the Radiological Section of the Canadian Medical Association decided to publish in the *Canadian Medical Association Journal* a series of papers the purpose of which is to present to the general profession an authoritative statement concerning the ever-enlarging field of X-ray and physiotherapy. In a Foreword in the January number of the *Canadian Medical Association Journal* the Editors refer to this program in the following statement: "We intend to publish a series of papers, designed for the general practitioner and the man working in the small hospital, dealing with the theory and practical applications of radiology and physiotherapy in their various aspects. These papers will be written by men expert in these particular fields and will be submitted for comment to specialists and others, in the hope that all sides of the subjects will be fully canvassed."

Dr. E. E. Shepley, of Saskatoon, Saskatchewan, has been appointed by the Radiological Section of the Canadian Medical Association to have general charge of this ambitious program, and he already has a large number of papers contributed and on

the way. We bespeak for Dr. Shepley the hearty co-operation of our American confrères when he appeals for help in carrying out this educational work.

L. J. CARTER, M.D.

on Radiology. All coming *via* Chicago may secure reservations by writing me. It is more pleasant to travel together.

I. S. TROSTLER, M.D.

812 Marshall Field Annex, Chicago.

## MINNESOTA RADIOLOGICAL SOCIETY

The midwinter meeting of the Minnesota Radiological Society was held February 14, 1931, at the Minnesota Club, St. Paul, Minnesota. The following program was presented:

Roundtable Discussion of Cases of Diseases of the Bones and of the Thorax. Conducted by R. G. ALLISON, M.D., Minneapolis.

Roundtable Discussion of Cases of Diseases of the Gall Bladder and of the Gastro-intestinal Tract. Conducted by JOHN D. CAMP, M.D., Rochester.

Roentgenologic Changes Seen in Cases of Boeck's Sarcoid and Related Lesions. S. A. MORTON, M.D., Rochester.

Correlation of the Various Factors Involved in the Classification of Chronic Arthritis. M. J. SHAPIRO, M.D., Minneapolis.

Pulmonary Metastases. EUGENE T. LEDDY, M.D., Rochester.

The Medical Histories of Cases of Carcinoma of the Stomach. JACOB SAGEL, M.D., Minneapolis.

## GOING TO PHILADELPHIA?

The American Medical Association holds its 1931 Session there June 8 to 12, inclusive.

The Pennsylvania Lines have furnished me with a diagram of a sleeping car on the train leaving Chicago at 12:30 p. m. and arriving at Philadelphia at 7:43 a. m. the morning of the first meeting of the Section

## BOOK REVIEW

THE ORIGIN OF LYMPHOSARCOMATOSIS AND ITS RELATION TO OTHER FORMS OF LEUKOSIS IN WHITE MICE. By CARL KREBS, H. C. RASK-NIELSEN, and AAGE WAGNER. *Acta Radiologica*, Supplement X. Stockholm, 1930. pp. 53, with 15 plates.

This report of experiments and observations on 16,900 white mice is most interesting in that it appears to show that, in such animals, lymphosarcoma is the result of lowered resistance, and that such depression of resistance may be brought about by exposure to roentgen rays. Unfortunately, as an experimental report this communication cannot be regarded as a model. So many essential details have been omitted that while the main results must be accepted as proved, many subsidiary points remain obscure, and the interpretations advanced cannot be analyzed satisfactorily. The doses given are not accurately described. In one place it is stated that to obtain "takes" in about 50 per cent of the animals the entire body of the animal had to be exposed to about 75 per cent of a lethal dose (minimum dose that will kill a mouse weighing from 15 to 20 grams within two weeks), and this was regarded as equal to about four-fifths of the human erythema dose through 5 mm. of aluminium. The quantity and quality of the rays are not specified. But when the dose was reduced to one-half the human erythema dose (about 60 per cent of the lethal dose), the percentage of "takes" di-

inished greatly. Further on the statement is made that "the smallest local irradiation given was of two erythema doses, applied in a single exposure on barely one-third of the animal's body at the hindmost part. Most of the doses were somewhat larger, however." That exposure of part or of the entire body of animals to roentgen rays should act to lower resistance to transplanted tumors is not surprising. However, these experiments do not furnish any clue to the factor or factors involved in such depression of resistance. Moreover, the possibility that such depression may have been partly due to factors other than irradiation has not been excluded.

Krebs, Rask-Nielsen, and Wagner never found bacteria in any of the tumors, thus confirming the work of Korteweg. Aside from the effect of roentgen irradiation in decreasing resistance and thus increasing the transplantability of lymphosarcoma, the most interesting results were that the majority of such transplanted tumors disappeared spontaneously, that it was possible to keep two strains alive for many generations, and that irradiation apparently facilitated

the spontaneous occurrence of leukemic changes.

But perhaps the most interesting part of the report is the description of the lymphosarcomatous lesions found at necropsy. While such lesions may differ slightly from those occurring in human beings, one experienced in human lymphosarcoma must be impressed by the surprising analogy. Another noteworthy point is the tendency of the blood of affected animals to exhibit leukemic changes. As the total number of leukocytes increased the percentage of polymorphonuclear cells diminished and the percentage of lymphoblasts increased.

In attempting to explain why, in view of the atrophy of the lymphoid structures previously shown by Heineke, Ziegler, Fabricius-Moeller, Murphy, Morton, and others, exposure of their animals to roentgen rays should have given rise to leukemoid changes, Krebs, Rask-Nielsen, and Wagner favor the correlation theories of Ziegler and Naegeli, but they are not able to prove such a relationship and admit that similar disturbances may be produced by other means than roentgen rays.

A. U. DESJARDINS, M.D.

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## APPARATUS

**A New Model Radium Emanation Plant.** Alexander J. Allen. *Jour. Cancer Research*, August, 1930, XIV, 461.

The author describes a new model emanation plant in which a two-stage mercury diffusion pump is used in connection with a Megavac oil pump. The parts subject to strain are made of heavy pyrex glass. He feels that the apparatus is efficient, compact, and relatively inexpensive. The use of pyrex glass makes for ruggedness of construction.

JOHN R. CARTY, M.D.

**Roentgen-ray Tubes, with Complete High Tension Protection up to 200 K.V.** A. Bouwers. *Strahlentherapie*, 1930, XXXVIII, 157.

The author, who has developed the Metalix tube, describes an equipment which is shock-proof up to 200 K.V. and 8 milliamperes. A number of illustrations demonstrate the construction.

ERNST A. POHLE, M.D., Ph.D.

**Nitrogen Peroxide from the Mechanical Rectifiers of a Deep X-ray Therapy Plant.** Rollo K. Newman. *Med. Jour. Australia*, May 3, 1930, I, 581.

In a room of cubic capacity, 36,790 liters (1,300 cubic feet), the total volume of nitrogen peroxide produced by running an X-ray machine at 200 K.V. and 30 ma. for 100 minutes was 2.13 liters, as measured by absorption in sodium hydrate.

The machine was of the two-unit type, employing the familiar and efficient rotating to-roid system and spherical collectors.

J. G. STEPHENS, M.D.

**The Half Value Layer Meter of Christen in a New Form.** H. Th. Schreus. *Strahlentherapie*, 1930, XXXVII, 193.

For practical purposes, a simple and inexpensive instrument to determine the quality factor in therapy is badly needed. The author has made an attempt at improving the half

value layer measuring apparatus of Christen, and hopes that the manufacturers will soon offer a suitable model to the roentgenologist.

ERNST A. POHLE, M.D., Ph.D.

**A Superficial Therapy Apparatus with Constant Output.** W. Hondius Boldingh. *Strahlentherapie*, 1930, XXXVIII, 165.

A movable apparatus is described, designed especially for skin therapy. It operates at 45 K.V. and has a stabilizer which maintains the transformer potential constant within 3 per cent. A time switch permits one to set the exposure time for various technics in r-units. Because of the constancy of the output, recalibration, according to the author, is necessary only at long intervals.

ERNST A. POHLE, M.D., Ph.D.

**A New Measuring Device for Very Small Light Intensities.** B. Rajewsky. *Strahlentherapie*, 1930, XXXIX, 194.

A good photo-electric cell measures light energies as low as  $10^{-7}$  erg per square centimeter per second. The author describes, in this article, an instrument designed similar to the counter of Geiger and Müller, for small intensities of roentgen rays, beta and gamma rays of radiation. By using an amplification system, the counting of the galvanometer deflections can be recorded automatically or over a loud speaker. Thus, the sensitivity is increased about 20,000 times over that of the photo-electric cell. For counts of twenty minutes, the error amounts to approximately plus or minus 2 per cent.

ERNST A. POHLE, M.D., Ph.D.

**The Effect of Intensifying Screens in Relation to the Quality of the Radiations in Radiologic Technic.** Vittorio Podestà. *Rivista di Radiologia e Fisica Medica*, May, 1930, II, 336.

The author describes an experimental apparatus he has constructed to study photographic screens, with results as follows: The luminosity of the screen increases not only with the intensity of the rays but also with an

increase of the hardness of the rays (decrease of wave length), the latter because of the combination of effect in the film and intensifying screen. With an increase of voltage up to 85 kilovolts the increase of effect is regular, then it rises suddenly and evens off at about 120 kilovolts. Between these two voltages the maximum increase of photographic effect is obtained.

E. T. LEDDY, M.D.

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A Practical X-ray Serialograph. A. I. Arneson. *Am. Jour. Surg.*, June, 1930, VIII, 1243.

The author has constructed a tunnel  $20 \times 24$  inches which will allow six separate exposures on one  $10 \times 12$  film, each one  $4 \times 5$  inches in size. This tunnel is suspended on an overhead trolley which runs on a one-inch gas pipe suspended from the ceiling. It is counterbalanced by an appropriate weight which runs in one of the nickel-plated standards of an old X-ray tube stand.

The advantages of this apparatus are that it can be pushed out of the way of the fluoroscope and yet is instantly available. It is easy by this method to make films of the duodenal cap in the upright position.

HOWARD P. DOUB, M.D.

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The Calibration of Grenz-ray Tubes. O. Gfrörer. *Strahlentherapie*, 1930, XXXVI, 786.

The author has carried out a considerable number of measurements on low voltage apparatus and tubes with the Lindemann window. He concludes that fluctuations in the primary line are of much more influence to the emission of X-rays of long wave length than in the ordinary roentgen apparatus. For their elimination, it is necessary either to have automatic potential regulation or to check the output of the tube during the entire treatment. The voltmeter in the primary circuit does not give accurate readings of the secondary potential. All apparatus for use on low voltage tubes should be calibrated uniformly as to the

tube potential. Numerous tables and curves illustrate the results of his investigations in detail.

ERNST A. POHLE, M.D., Ph.D.

## APPENDIX (DIAGNOSIS)

The Roentgen Diagnosis of Chronic Appendicitis. Henry J. Walton and Samuel Weinstein. *Am. Jour. Roentgenol. and Rad. Ther.*, December, 1930, XXIV, 631.

In a routine study of 1,000 consecutive gastro-intestinal examinations, there was roentgen evidence of a pathological appendix in 152 instances, or 15.2 per cent. In the series presented the diagnoses were based on: (1) direct findings; (2) indirect findings. Of the direct evidences, the visualized appendix, which empties slowly and is persistently tender to palpation, is the most common. Of the indirect evidences, the ileal and colonic stases are the most common. The diagnosis was confirmed either clinically or at operation in 133 cases, or 87.5 per cent. The incidence of appendicitis was noted to be greatest between the ages of 20 and 50 years.

The authors include a tabulation showing the incidence of the various types of gastro-intestinal pathology, one showing the distribution of the ages in the various groups as well as sex, while another shows the percentage of agreement between the roentgen and clinical findings.

J. E. HABBE, M.D.

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Roentgenologic Observations of the Appendix. Werner Knothe. *Röntgenpraxis*, Dec. 1, 1930, II, 1057.

The value of a roentgenologic examination for the diagnosis of diseases of the appendix is still debated. The filling or non-filling of the appendix after a barium meal has been used as a diagnostic sign. The author uses a barium enema and finds that he can, by this method, demonstrate the appendix as often as when the barium meal is used. A normal appendix is usually demonstrable, and only very few roentgenologists believe, at the present time, that visualization of the appen-

dix indicates pathology. Peristaltic waves can be observed occasionally, and a sphincter-like contraction at the base may often be seen. Failure of roentgenologic demonstration in combination with localized tenderness indicates a pathological process. Several cases, with reproductions of films, illustrate the author's method.

H. W. HERKE, M.D.

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**The Pathological Appendix.** Albert F. R. Andresen. *Med. Jour. and Record*, Aug. 20, 1930, CXXXII, 178.

What is meant by the term "pathological appendix" as returned by the roentgenologist, and what shall be done for a patient with such a diagnosis? Such a conclusion from X-ray evidence is based on a definite group of findings, including filling of the appendix with barium, failure to expel this in normal manner, with deformity and abnormal functioning of cecum, sometimes with reflex pylorospasm. Such findings indicate a condition usually known as "chronic appendicitis," which is itself usually a part of a general gastro-intestinal infection. Operation is indicated only in cases showing persistent symptoms due to complications. Eradication of all infective foci, of which the appendix may be one, with proper hygienic and dietetic care both pre-operative and post-operative, is essential.

W. W. WATKINS, M.D.

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**The Roentgen Symptoms of Post-appendicitic Abscesses.** Rudolf Pohl. *Fort-schr. a. d. Geb. d. Röntgenstr.*, July, 1930, XLII, 19.

Fluoroscopic and radiographic observations during and after opaque clysma, eventually aided by air insufflation, and also following expulsion is the technic described by the author. Careful roentgen exploration never aggravates. In cases offering diagnostic difficulties valuable information may be obtained, though a definite diagnosis usually may be made only by correlation of all anamnestic clinical and roentgenologic data.

The following classification is given:

(1) Perityphlitic abscess—

- (a) completely encapsulated,
- (b) communicating with cecum and eventually extending into adjacent tissues.
- (2) Abscesses originating from an appendicitis but located distant to the cecum—
  - (a) pelvic abscess,
  - (b) subphrenic abscess (not discussed),
  - (c) intraperitoneal abscess somewhere else in the abdomen.

A number of good illustrations elucidate the author's points—filling defects, displacements, irritability of bowel, abscess cavities filled or lined with contrast medium, stenoses, etc. For differential diagnosis, tuberculosis, fungus infections, and invaginations must be considered, besides extra-intestinal pathology, such as parametritis, abdominal metastases, ovarian tumors, etc.

This is an interesting paper, and well worth reading.

HANS A. JARRE, M.D.

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## BLOOD CHANGES

**Researches on the Blood of Radiologists.** Jacques Lavedan. *Radiophysiologie et Radiotherapie*, 1930, Vol. I, Fasc. IV, 477.

This paper is based upon the results of repeated blood examinations in a large number of persons of both sexes, engaged in X-ray and radium work. These comprise radiologists, technicians, and the general personnel of the Radium Institute of the University of Paris. The conditions of work as regards protection, hours of work, and holidays are given in detail, and these appear to be in conformity with accepted international standards. Only in the case of workers with the radon extraction apparatus was the possibility of considerable exposure present, although it was found that in some cases in which theoretically adequate protection had been provided, small defects were present which were capable of rectification. It was found that there is a very great variation in the effect of exposure to radiation on the blood in different individuals.



In some cases, definite changes were found after only a few weeks of exposure, while in others, working under identical conditions, no changes were found even after years of exposure. The commonest modification found in the blood picture is an increase in the mononucleated cells, either relative, with a diminished total leukocyte count, or absolute, with a normal or increased total count. (Under "mononucleated cells" are included all varieties of lymphocytes, mononuclears, and transitional cells.) In the most marked cases there may be a true inversion of the ratio of mononuclear to polymorphonuclear cells. In the opinion of the author this change cannot be considered as of grave importance. There is no evidence that the resistance to infection is lowered, nor can it be regarded as a pre-leukemic condition. It was found that a holiday of a few months or even weeks resulted in a return of the blood count to normal, or, at any rate, in a marked amelioration of the condition.

The author believes that the occurrence of these changes in the blood of X-ray and radium workers is always to be regarded as an indication that the protection is insufficient, even when the latter appears to be theoretically perfect, and that the blood counts can always be restored to normal by increasing the protection. Great importance is attached to the maintenance of a strict discipline in X-ray and Radium Departments, in order to insure that the rules of personal protection shall not be relaxed under any pretext whatever. However good the protection, it is urged that all X-ray and radium workers be submitted to blood examinations three or four times a year, since the blood, being the most radiosensitive tissue in the body, can give the earliest indication of injury from radiation.

WALTER M. LEVITT, M.B., D.M.R.E.

**The Behavior of the Blood Phagocytes in Irradiated Guinea Pigs.** Ludwig Pincussen. *Strahlentherapie*, 1930, XXXIX, 103.

The phagocytosis in the blood of guinea pigs before and after exposure of the animals

to a quartz mercury vapor lamp and a Vitalux lamp was studied by the author. From the ear, 0.1 c.c. of blood was taken, blown into a paraffinized test tube containing 0.5 c.c. of a solution which was made up by dissolving 0.5 gram NaCl and 0.4 sodium citrate in 100 c.c. of water. This was shaken well and then hydro-kollag 300 J. D. Riedel-E. de Haën added. The latter had been diluted with water twenty times, centrifuged ten minutes at 2,000 revolutions, and the resulting suspension was used for the experiments. Two drops of the blood suspension were added to the centrifuged solution, stirred with a glass rod, and then placed for one hour in a water bath at 37 degrees centigrade. After that, microscopic slides were made and stained with the Pappenheim method. It appeared that the phagocytic action of the leukocytes, measured by the percentage of phagocytizing cells, was not increased by ultra-violet nor by visible light. An increase could be observed only following a rise of the temperature from 37 to about 39½ degrees centigrade.

ERNST A. POHLE, M.D., Ph.D.

**Fluctuations of the Blood Pressure Following X-ray Treatment and Their Clinical Significance.** Hans Pausdorf and W. Nell. *Strahlentherapie*, 1930, XXXVIII, 40.

Fluctuations in the blood pressure observed immediately following exposure to roentgen rays must be separated from those appearing 24 or 48 hours later. The blood pressure changes immediately after irradiation are irregular, while those manifesting themselves from one to two days after the treatment show definite cycles. Following an extensive treatment they may re-appear even between the twenty-fifth to the thirty-fifth day or between the fiftieth to the seventieth day. The lowering of the blood pressure is not due to the effect of roentgen rays upon the suprarenals but can be explained by a systemic reaction caused by the decay products formed during and following the exposure. They produce an increased irritability of the vasodilating nerves. The degree of the blood pressure

changes may be used as a factor in determining the prognosis and the proper interval between treatments.

ERNST A. POHLE, M.D., Ph.D.

**Further Studies of the Effect of Radiation on Blood Cholesterol in Malignant Disease.** Walter L. Mattick and Melvin C. Reinhard. *Jour. Cancer Research*, August, 1930, XIV, 426.

The authors determined the cholesterol content of the blood of twenty-five carcinoma patients, who had received high voltage therapy, at one-half hour intervals, beginning from thirty minutes before treatment to three hours afterwards. The Sackett modification of Bloor's method for the cholesterol content of the whole blood was employed. No characteristic change in the cholesterol level of the whole blood was noted in the three-hour period.

JOHN R. CARTY, M.D.

**Comparative Studies of Blood Injuries Following Roentgen Irradiation with the Old Treatment Technic and the Ray-proof Metalix Tubes.** Walter Fürst. *Strahlentherapie*, 1930, XXXVII, 659.

During the treatment of patients by the open tubestand method, a considerable amount of indirect radiation reached the body. The author has made an attempt to measure this undesirable amount of additional radiation by comparing the old technic with the modern procedure using Metalix tubes. The total radiation received by the patient with the two methods is in the ratio of seven to five. He believes that the systemic effect as well as the injuries to the blood are much less if the patient is treated by the modern method.

ERNST A. POHLE, M.D., Ph.D.

### BONE (DIAGNOSIS)

**Bone Changes in a Case of Chronic Empyema.** T. Dale. *Acta Radiologica*, 1930, XI, Fasc. 5, No. 63, p. 537.

The author reports in detail a case displaying the familiar bone changes seen in chronic

pulmonary diseases, in which the long bones revealed periosteal thickening and widening of the cortex. After rib resection and drainage the patient recovered from empyema. Examination by roentgenograms of the bones of the arms, legs, hands, and feet, a year and a half later, showed them to be practically normal. The author believes that these bone changes are due to a combination of toxemia and endocrine disturbances.

ALAN L. HART, M.D.

**Contributions to the Pathologic Osteology: (A) Unilateral Patella Partita; (B) Joint Formation in the Body of the First Rib.** A. Pickhan. *Röntgenpraxis*, Nov. 1, 1930, II, 969.

(A) The fact that the patella partita may be found on only one side is not definitely known. If it is bilateral there is usually no difficulty in the differential diagnosis from a fracture. Three cases of this congenital anomaly are described by the author, who states that it may be differentiated from fractures by the smooth edges of the dividing line, and by the absence of any callus.

(B) The formation of a joint in the body of the first rib is a very rare anomaly. Such a case is described and some reproductions are shown.

H. W. HEFKE, M.D.

**The Symphysis Pubis in the Roentgen Examination of the Sacro-iliac Joint.** W. Edward Chamberlain. *Am. Jour. Roentgenol. and Rad. Ther.*, December, 1930, XXIV, 621.

The author demonstrates that the ordinary roentgen examination of the sacro-iliac region does not demonstrate the presence of sacro-iliac relaxations or subluxations. The technic used by the author consists of five films—a stereoscopic pair in posterior projection, with the symphysis pubis and the entire pelvic brim in the field; a lateral projection centered at the lumbosacral junction, and two anterior projections, the patient standing, one with the patient's entire weight borne on the right leg, and the other with his weight on the left leg.

These latter films, made with the weight bearing on one leg only, serve to demonstrate radiographically a difference in elevation of the pubis, the upward movement of this bone serving as the long arm of a kymographic recorder to demonstrate an abnormal degree of rotatory motion in the sacro-iliac joint, hence making possible the diagnosis of "sacro-iliac relaxation." In the author's series of cases, the side of acute back symptoms is almost always the same side as that showing the high pubis. With this technic, normal individuals were first studied and normal movements were measured at the symphysis pubis in the male and non-pregnant female. The article is well illustrated.

J. E. HABBE, M.D.

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**A Contribution to the Etiology of the So-called Talalgia.** J. Odessky. *Röntgenpraxis*, Dec. 1, 1930, II, 1092.

Certain bone changes, which may be demonstrated by a roentgenologic examination, are the cause for the so-called talalgias. These changes consist of the formation of a spur on the lower surface of the heel and proliferative changes of the upper and posterior part of the os calcis. This latter process is an osteoperiostitis in the region of the insertion of the tendon of Achilles. Any infection, and not gonorrhea alone, may be the etiological factor. It cannot be said definitely at the present time whether or not cholera may be considered as a causative factor. The pains which accompany this are usually due to the inflammation of the bursa and the osteoperiostitis on the upper and posterior portions of the os calcis. Surgical removal of the spur does not always relieve the pain.

H. W. HEFKE, M.D.

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### BONE (THERAPY)

**Fractures of the Os Calcis.** Giuseppe Rottolo. *Clinica Chirurgica*, 1930, VI, No. 5, p. 483.

This article, which is a statistical study of one hundred cases and a clinical review of fifteen cases, is primarily concerned with a

discussion of the two types of treatment, namely, operation and manipulation and immobilization. Fractures of the os calcis represent 1.49 per cent of all fractures and 3.95 per cent of fractures involving bones of the foot. The author is an advocate of the bloodless method, for which he shows after-results at least not worse than those obtained by operative procedures. The patient is allowed to walk on the fifth day and physiotherapy is started on the fortieth day. Operation is advised in the avulsion fractures of the posterior tuberosity and arthrodesis in bad sequelæ. Ankylosis occurs spontaneously if the articular surfaces of both the os calcis and astragalus are involved.

The os calcis is crossed by four systems of trabeculae. Between the anterior apophysis and thalamic, both of which run vertically, there is a sort of medullary cavity which constitutes a weak point in crushing fractures. The plantar system is horizontal and the system of Achilles runs in the direction of the tendo achillis.

Fractures of the os calcis are classified by Destot and Morel into four types: Fractures of the body of first, second, or third degree, varying from a subthalamic fissure to the bursting of the whole bone; fractures of the greater apophysis; fractures of the lesser apophysis, and fractures of the posterior tuberosity. The great majority of fractures of the os calcis result from a crushing mechanism. The lesion starts with a deepening of the thalamus where the various systems of trabeculae converge to form a solid wall; crushing of the body occurs next, followed by irradiation of lines of fracture to the posterior tuberosity. These fractures may be associated with fractures of the inferior third of the bones of the leg or with the other bones of the tarsus.

The X-ray examination is made in the lateral and antero-posterior directions. Sometimes atypical positions are chosen in order to direct the central ray parallel to the planes of fracture. Stereoscopic views are occasionally made. It is of interest to note that ten cases of fractures of the body showed enlargement of the transverse diameter in the antero-posterior films. The X-ray examination is espe-

cially important because it shows the position of the fragments and is the only guide to the proper manipulation of the fracture previous to immobilization.

The author's personal method of treatment is described. The article is well illustrated and a good bibliography is appended.

V. WITTING, M.D.

**The Effect of Irradiated Ergosterol on the Healing of Experimentally Produced Fractures in Animals.** Howard A. Swart. *Jour. Bone and Joint Surg.*, April, 1930, XII, 360.

Leg fractures were studied in forty rabbits and twenty rats, half on a standard diet, and half receiving in addition small doses of viosterol. Roentgenograms taken at eight-day intervals, and tissue from animals killed at intervals of five days failed to show significant differences between the treated animals and the controls.

PAUL C. HODGES, M.D.

**The Relationship between the Hypophysis and the Formation of Callus in Bone: An Experimental Study.** A. Spinelli and Ferdinando Talia. *Archivio di Radiologia*, July-October, 1930, VI, 748.

In a series of experiments carried out on dogs with fractured limbs in which the hypophysis was irradiated, the authors found the following: (a) after irradiation of the hypophysis with stimulating doses (1) precocious formation of bony callus, (2) more rapid evolution of the callus, and (3) greater osteoblastic formation and greater periosteal reaction; (b) after inhibiting doses (1) delayed formation of callus, (2) delayed development.

E. T. LEDDY, M.D.

**Recovery from Fracture of the Neck of the Femur in a Nonagenarian.** Roscoe C. Webb. *Ann. Surg.*, December, 1930, XCII, 1112.

Roentgenograms of a ninety-three-year-old woman, taken on the day of injury, showing an intracapsular fracture of the neck of the left femur, with the distal fragment displaced

upward about one inch and rotated outward, and then again four months later, taken in abduction, showing the fracture to be in perfect position, with no absorption of the femoral neck, are unusually convincing. The author used the artificial impaction method of Cotton, and followed with the Whitman abduction and a plaster cast for three months. Besides general nursing care the patient was made to lie on her abdomen for one hour, three times daily. The fracture was set four days after the injury. An excellent portable roentgenogram was obtained of the fracture while the patient was under general anesthesia, and before the plaster cast was applied.

F. B. MANDEVILLE, M.D.

### BONE DISEASES (DIAGNOSIS)

**Kienböck's Disease of the Semilunar Bone.** N. Porro. *Archivio di Radiologia*, July-October, 1930, VI, 690.

The author reports and discusses, from a clinical and roentgenologic point of view, six cases of Kienböck's disease.

E. T. LEDDY, M.D.

**The Roentgenological Differentiation of Benign and Malignant Diseases of the Bones.** Robert Kienböck. *Med. Klinik*, Nov. 7, 1930, XXVI, 1655.

Between the terms "benign" and "malignant" are many grades, and the exact differentiation of them is hard to make. Only the osteomas (cartilaginous exostoses) are absolutely benign; only the blastomas (carcinomas and sarcomas) are absolutely malignant. Even in these groups, some are more benign than others (metastases of a thyroid carcinoma, adenocarcinoma). The chondromas of the skeleton should be called "semi-malignant"—they might stay benign or might degenerate into chondrosarcomas. In this group should be named also the lymphosarcomas, myelomas, xanthomas, and lipoidomas. Giant-cell tumors and the generalized osteitis fibrosa cystica are "pseudo-malignant." They are only bone dystrophies and not real tumors—both stay be-

nign and do not develop into sarcomas. Paget's disease is somewhat different; in from 3 to 5 per cent of all cases, a sarcoma develops, although the disease *per se* is benign and chronic. Some purely infectious bone diseases can be called malignant, as they progress rapidly and lead to the death of the individual. No single clinical symptom which is pathognomonic is known. The roentgen signs also are not so definite that one alone proves or disproves the benign or malignant character. Chondromas, bone cysts, and carcinomatous metastases might give very similar pictures. The differential diagnosis between sarcomas and hematomas, tuberculosis, syphilis, and purulent osteomyelitis is sometimes very difficult. It is not possible to give an easy guide for making a diagnosis and differentiating benign from malignant lesions. The entire roentgenologic picture, sometimes only with the help of the clinical findings, leads to a correct diagnosis.

H. W. HEFKE, M.D.

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A Case of Generalized Osteitis Deformans (Paget), with Secondary Malignant Degeneration. Viggo Genner and Harald Boas. *Acta Radiologica*, 1930, XI, Fasc. 4, No. 62, p. 398.

The authors describe a case of generalized osteitis deformans which developed a sarcoma of the scapula. The possible etiologies of Paget's disease are discussed. The pathology and roentgen findings of osteitis deformans are described in detail.

M. J. GEYMAN, M.D.

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Osteochondritis Dissecans, Considered from the X-ray Standpoint. Gösta Jansson. *Acta Radiologica*, 1930, XI, Fasc. 1, No. 59, p. 33.

Perthes' disease, Osgood-Schlatter's, Köhler's, Kienböck's, etc., have now been collected under one head as epiphyseal necroses.

In 1888, König announced his theory of spontaneous, aseptic necrosis in epiphyses, with the separation of necrotic bone as the result; he believed that trauma was only a

contributory factor added to an unknown basic cause. Other students of this disease held that injury was the sole etiologic factor. This view has not been substantiated by experimental research.

In 1922, Lieck identified osteochondritis dissecans with the other epiphyseal necroses. He believed the underlying cause was of an endocrine nature.

The author upholds Axhausen's theory that aseptic necrosis in an epiphysis results from an embolus and the consequent infarct. Localized bone necrosis, produced experimentally by an electric current, shows a pathologic picture resembling that of osteochondritis dissecans as well as Perthes' and Köhler's diseases. While the infarct is developing and before there are any loose fragments of bone in the joint, the patient has only mild rheumatic pain; but after the separation of the pieces of necrotic bone and cartilage, the patient develops the typical symptoms of sudden pain and fixation of the joint. Jansson believes that the lesions in the epiphyses are analogous to the anemic infarcts seen at autopsy in various organs. He states that the cartilage is not involved in the necrosis but is undermined by the necrotic process in the bone itself. Slight trauma may cause the affected area of bone to be torn off, carrying a section of normal cartilage with it. He has studied a large number of cases of traumatic "joint mice" and has never found them to contain normal joint cartilage. He believes they probably result from trauma to an arthritic joint, and consist of fractured fragments of pathologically changed bone. Films of the joint in these cases have not showed defects in the condyles of the femurs.

Osteochondritis dissecans usually occurs in young adults, although cases are seen in older persons. It is commoner in men than in women, may be bilateral, and is most often found in the knee and in the medial condyle of the femur. As a rule, the patient gives no history of any significant injury preceding the onset of symptoms. Roentgenograms are the most important method of diagnosis. It is essential that both antero-posterior and lateral films of the affected joint be made. The typical case presents on the films a large or

small area of bone destruction near the articular surface of the medial condyle of the femur. This defect may appear empty or may contain small pieces of bone. It does not protrude beyond the articular surface. After the fragments have separated and fallen into the joint, one can usually see an irregular defect in the condyle, as well as the free bone fragments in the joint. Small "joint mice" may be connected by a thin strand, with the defect in the femur.

The author reports ten cases of osteochondritis dissecans in persons ranging from 21 to 46 years of age. Two of the patients were women; eight were men. He gives the clinical history and operative findings, in addition to the X-ray evidence. The roentgenograms of the joints are supplemented by films of the fragments of bone removed from the joints at operation. These "joint mice" are seen to consist of both bone and cartilage; the bone sometimes shows areas of rarefaction and bone destruction. In some instances these free bodies consisted of cartilage in which were embedded small fragments of bone. Some of them had been fractured, and a few had one surface entirely covered with cartilage. He emphasizes the apparent impossibility of so much bone destruction occurring in the short time that generally elapses between the trivial injury, often recalled by the patient, and the onset of the symptoms of osteochondritis dissecans. It is his belief that this strongly destructive character of osteochondritis dissecans speaks for an embolic origin rather than a traumatic one, and he concludes that it forms an etiologically distinct group of joint diseases.

A. L. HART, M.D.

**Two Cases of Unusual Localization of a Chronic Bone Abscess (Brodie).** A. Mariupolsky. *Röntgenpraxis*, Nov. 1, 1930, II, 996.

The clinical and radiological appearances of chronic bone abscesses are well known. Of the nine cases observed by the author, two were found in the patella. This localization has not heretofore been described. The history and the clinical and surgical findings are described

in detail. Clinically, the knee joints were affected secondarily. The localization of these abscesses is usually around the epiphyses, but the two cases reported by the author and those published by other authors prove that the small bones may also be attacked.

H. W. HEFKE, M.D.

**Idiopathic Osteopsathyrose.** Leon Prus-sak and Natan Mesz. *Acta Radiologica*, 1930, XI, Fasc. 2, No. 60, p. 175.

The authors detail the history of the knowledge of this disease, starting a century ago with Lobstein, who was the first to describe the anatomical bone changes. Not until 1891 was the blue coloration of the sclera noted. At present the classical picture of this disease consists of (1) fragility of bones; (2) slate blue sclera, and (3) disturbances of hearing. The auditory symptoms are usually present in adults, but absent in children. There are abortive cases exhibiting only one of the cardinal symptoms. This disease often has a heredofamilial distribution, although it may skip a generation and often does not affect all the members of a family. It does, however, occur sporadically now and then.

The most prominent symptom is the fragility of the bones. The osseous changes, as seen on the roentgenogram, are: (1) thinning of the cortex; (2) widening of the marrow cavity; (3) calcium deficiency; (4) multiple fractures. The periosteum and epiphyses are not involved. Any bone may be affected, but the long bones, especially of the legs, suffer most frequently. The fragility of bones may reach such a degree that even a vigorous muscle contraction will produce a fracture. Some cases, with over a hundred fractures have been reported. These fractures commonly occur in infancy and early childhood, reach their height of incidence during adolescence, and are rare after 26 years of age. They often cause so little pain that the patient is unaware of them and their discovery is first made by the X-ray examination. The callus which forms is well-developed but so poor in calcium that it throws a faint shadow on the films of the bones. The healing proceeds with moderate rapidity and is often so com-

plete that it is difficult to recognize the sites of earlier fractures on roentgenograms. Most of the fractures occur spontaneously without serious injury, or even while lying in bed. Great deformity of the limbs may result from numerous fractures.

The blue color of the sclera is thought to be due to an unusual transparency of this coat of the eye-ball, permitting the choroid pigment to show through. The skull shows protuberances in the forehead, occiput, and temples. These cranial deformities plus relaxation of the structures in the middle ear, plus otosclerosis, are considered as the probable cause of the disturbances in hearing that develop during adolescence. Other inconstant symptoms are as follows: changes in electrical reactions of the muscles, thinning of the hair, trophic changes and pigment deposits in the skin, abnormal secondary sexual characteristics, corpulence, and hypothyroidism.

In the differential diagnosis there must be considered: (1) osteomalacia; (2) fractures in rachitic children; (3) osteogenesis imperfecta. The X-ray examination will not distinguish between idiopathic osteopsathyrose and osteomalacia; clinical data are necessary. Rachitic children never show so many fractures as patients with idiopathic osteopsathyrose; furthermore, the rachitic fracture develops a strong callus rich in calcium, and the cortex in rickets is thickened and the epiphyses involved in contra-distinction to idiopathic osteopsathyrose. Osteogenesis imperfecta presents a pathological picture very similar to that of idiopathic osteopsathyrose, but runs a different clinical course. Children afflicted with the former disease are often born with fractures or sustain fractures in the first days of life, are always very delicate, and usually die in very early childhood; whereas, patients with idiopathic osteopsathyrose are well-built physically and have a good prognosis as to life, while their fractures come on in later childhood and reach their peak during adolescence. Possibly these two diseases represent the same entity, occurring in different periods of life.

Nothing definite is known of the pathogenesis of idiopathic osteopsathyrose. Some students believe it is a developmental defect;

others that it is of endocrine origin, and still others that it is based on chemical changes in the composition of the bones.

The diagnosis is easy in cases presenting two of the cardinal symptoms, but is likely to be very difficult when only the bone fragility occurs. The authors report three cases as follows, two of which were typical, and the third showed multiple fractures and a chronic, organic disease of the brain:

(1) This case, a girl of 12 years, exhibited multiple fractures, blue sclera, hereditary tendency, corpulence, and precocious puberty.

(2) This case, a boy of 2½ years, showed the characteristic personal symptoms, but no hereditary tendency.

(3) This case, a boy of 8 years, failed to present the hereditary traits, but presented typical bone changes. He had epileptiform attacks and pyramidal symptoms, and was an imbecile as well.

The article is illustrated by a number of plates showing the physical state of the patients, and bone injuries and deformities.

A. L. HART, M.D.

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Melorheostosis (Léri) and the Generalized Osteitis Condensans or Osteopoikilia (Albers-Schönberg). A. Kahlstorf. *Röntgenpraxis*, August 15, 1930, II, 721.

A new case of melorheostosis is described by the author. This rare bone affection is a disease which attacks the bone of only one extremity in a segment-like band of osteosclerotic bone, and which, contrary to other bone changes, is not generalized nor present in separated foci. It appears that the bony sclerosis begins during the time of bone-growth in childhood or adolescence. The clinical symptoms, which usually appear late, are slight compared with the massive bone changes. In the author's case, the band-like lesion suggests a congenital anomaly, nothing definite being known about the etiology or pathogenesis. The ten cases of this disease so far described in the literature are reviewed and a bibliography is given.

Another rare bone disease is the generalized

osteitis condensans (Albers-Schönberg), also called osteopoikilia. The twelve cases heretofore described in the literature are briefly reviewed, and another case is added. Multiple, small, dense areas were found scattered through the extremities. One has to do apparently with an anomaly of ossification which is clinically of no importance and leads to no symptoms.

H. W. HEFKE, M.D.

## BONE TUMORS (DIAGNOSIS)

**A Contribution to Chondromatosis of the Joints.** Hofmann. *Röntgenpraxis*, Sept. 15, 1930, II, 842.

Chondromatosis of a joint is usually limited to one joint alone. In the case reported by the author, the knee joint and elbow joint were involved. Traumatic influences are not responsible for this disease, but it may be caused by a development of these tumors from embryonal cells. Differential diagnostic difficulties do not often exist. However, arthritic changes may be associated with this disease.

H. W. HEFKE, M.D.

genic sarcoma in whom a pathological fracture has occurred is shortened 60 per cent. All the patients with fracture through giant-cell tumor are living, one to eight years. Fracture was followed by union in 3 of the 7 cases of endothelial myeloma; in 7 of the 9 cases of giant-cell tumor, and in none of the 26 cases of osteogenic sarcoma.

Pathological fracture may be postponed, or even prevented entirely, by early and continuous support. The failure to immobilize a limb in which a pathological fracture has already occurred may predispose to early dissemination.

HOWARD P. DOUB, M.D.

## CANCER (DIAGNOSIS)

**The Clinical Manifestations of Primary Bronchial Carcinoma.** Elmer H. Funk. *Jour. Am. Med. Assn.*, Dec. 20, 1930, XCV, 1879.

This essay is based on an analysis of the clinical features presented by sixty-one patients with primary carcinoma of the bronchus, in whom the diagnosis was verified by histologic examination of tissue removed. The predominance among men and the incidence after the age of 35, particularly from 35 to 45, are factors of significance in diagnosis. The author quotes Weller that the type of carcinoma occurring in the hilum, comprising perhaps 90 per cent of all cases, is practically always bronchiogenic. The clinical features vary greatly, depending on the following factors: (1) the location of the neoplasm and the rapidity of its growth; (2) the degree of bronchial obstruction produced; (3) the presence of secondary infection and suppuration; (4) the pressure on adjacent structures; (5) the occurrence of pleural involvement, which is not infrequently associated with effusion, and (6) the influence of local and general metastasis. The relative frequency of the local symptoms was as follows: cough, 88 per cent; expectoration, 67 per cent; pain, 72 per cent; hemoptysis, 45 per cent; dyspnea, 50 per cent. The general symptoms of weakness and loss of weight follow, as a rule, the occurrence of the local symptoms, and were sufficiently evident to be

**Pathological Fractures in Primary Bone Tumors of the Extremities.** Bradley L. Coley and George S. Sharp. *Am. Jour. Surg.*, August, 1930, IX, 251.

Pathological fracture occurred as a complication in 22.7 per cent of a series of 185 primary bone tumors of the extremities. This occurred in 25.7 per cent of endothelial myeloma, in 25 per cent of giant-cell tumor, and in 21.3 per cent of osteogenic sarcoma.

While it was found that three-fourths of the tumors occurred in the lower extremities, pathological fractures are most common in the upper extremities, and the upper end of the humerus was the region of greatest susceptibility to fracture. Fracture was the initial symptom in one-fifth of all the cases, but it did not occur as an initial symptom in any of the endothelial myeloma cases.

The life expectancy of a patient with osteo-



noted as a part of the present illness by the patient in 80 per cent of the cases.

In extra-thoracic metastases any organ may be involved. An early and significant finding, clinically, is metastasis to the supraclavicular nodes. In most instances extra-thoracic metastases were late phenomena. Fried and Buckley found central nervous-system metastases in fifteen of thirty-seven patients with bronchiogenic cancer. The primary tumor may be overlooked. The roentgenologic evidence may be most valuable in determining the presence and location of the tumor, especially when the hilar mass is sufficiently large and not obscured by the many secondary pathologic changes which occur in the lung and pleura. When these are present the roentgen picture may resemble numerous other pulmonary lesions.

Bronchoscopic observation represents the most recent and important advance in thoracic diagnosis, and is the only method by which an early diagnosis of bronchial newgrowth can be made, with reasonable certainty in the vast majority of patients. Certain conditions which cause confusion, but which a complete study should exclude in the majority of cases, are: tuberculosis; bronchial obstruction from other causes; pulmonary abscess; syphilis; pneumoconiosis, and pleurisy. Generally, the prognosis is bad, and a fatal outcome occurs within a relatively short period of time.

C. G. SUTHERLAND, M.D.

**Diagnosis and Treatment of Early Cancer of the Breast.** William L. Hearst. Jour. Iowa St. Med. Soc., September, 1930, XX, 400.

The early recognition of cancer of the breast is very important, for not until a reasonably accurate diagnosis is made will an operation for its removal be permitted, and the earlier the operation the more hope of cure. At present, operation is the only method whereby we may hope for a complete cure. The great majority of breast tumors are malignant (85 per cent or more according to Mayo), and a fair proportion of the benign ones develop malignancy. All tumors not positively proven to be benign should be removed, and the re-

moval should be *in toto*, with all infected and enlarged glands in the axillary space or any other place. After such an operation the breast should be radiated thoroughly and for a sufficient length of time. In more advanced cases the pectoralis major and fascia and muscle of the pectoralis minor should be removed, with the glands in all the spaces and supraclavicular area, extending to the chest wall. X-ray treatments should then be given as soon as possible and continued until all suspicion of recurrence is past.

W. W. WATKINS, M.D.

**A Case of Carcinoma of the Thymus, with Extensive Metastases, in a New-born Child.** George V. Bedford. Canadian Med. Assn. Jour., August, 1930, XXIII, 197.

This case presents a number of features which are unique, *viz.*, the combination of primary carcinoma of the thymus, with metastases in the liver, lungs, bones, and skin. Primary carcinoma of the thymus is rare, and metastases in the skin of an infant are exceedingly rare.

The child at birth was covered with a generalized eruption which was partly pustular and partly hemorrhagic.

X-ray examination four days after birth showed enlarged thymus, infiltrated shadows in the lungs, spontaneous fracture of four ribs, and rarefaction areas in both femora and both tibiae and fibulae.

Wassermann reaction was negative on two tests. Sections of tissue examined in the Department of Dermatology and Syphilology of the Mayo Clinic proved to be carcinoma of the thymus, with metastases in bones, lungs, liver, and skin.

L. J. CARTER, M.D.

**The Diagnosis and Treatment of Cancer of the Stomach.** Penn Riddle. Texas St. Jour. Med., September, 1930, XXVI, 348.

Of the deaths from cancer, 25 per cent are due to cancer of the stomach. The outstanding progress in the early diagnosis of cancer of the stomach has been due to the more extensive use of the X-ray, very little progress

having been made in the early recognition of the disease from the interpretation of clinical symptoms. Of the patients coming to the Mayo Clinic with cancer of the stomach, one-half are operated upon, and one out of four has an operable lesion. According to Balfour, the X-ray will correctly disclose from 96 to 98 per cent of organic gastric lesions, and three out of four of these are malignant. The problem is to train people to come early in the development of gastric symptoms. The treatment at present is entirely surgical. The X-ray is of little value in determining operability, and this can be learned only by exploration.

W. W. WATKINS, M.D.

**Primary Carcinoma of the Ureter.** Henry J. Lindner, Rigney D'Aunoy, and R. J. Mailhes. *Med. Jour. and Record*, Sept. 17, 1930, CXXXII, 290.

A case of primary carcinoma of the ureter is reported, being the forty-eighth case on record and the eighth diagnosed before operation, with a *résumé* of the salient clinical and pathological features of all recorded cases. No etiology can be ascribed, concurrent calculus being present in only eight cases. Hematuria, pain, and renal and ureteral dilatation are most frequently encountered. Diagnosis is difficult, but is greatly facilitated by a careful history, the use of cystoscopy, pyelography, and pyeloureterography. Radical operation is the treatment.

W. W. WATKINS, M.D.

**The Diagnosis of Cancer.** Francis Carter Wood. *Jour. Am. Med. Assn.*, Oct. 18, 1930, XCV, 1141.

While it is perfectly possible to have the lay public absorb a certain amount of information concerning the symptoms of cancer, after such absorption has taken place and the desired reaction has occurred, the profession is not in a position, speaking generally, to render efficient service to those who apply for it. The medical profession, as a whole, is not yet prepared to accurately diagnose the disease which it is called on to treat, at a stage which permits of effective therapeutic attack, nor are

all surgeons or radiologists prepared to offer the proper therapy. The facts are, at present, that at least half of the malignant tumors which occur are so inaccessible as to render an early diagnosis in no sense possible, and, in addition, even the accessible tumors are so rarely diagnosed in the early stages that only about 20 per cent are susceptible of operative treatment, with a probability of cure. A small percentage of the inoperable tumors are available for curative radiation therapy.

The pathologist is assuming a position of importance which he has not held since tumor diagnosis began. Pathologic control is important in modifying the present attitude of some surgeons, that the breast of any woman over 35 years of age, containing a few nodules, should be promptly removed *in toto*. In the vast majority of cases, the diagnosis, whether on frozen or embedded material, rises no higher than the intelligence of the pathologist and the breadth of his experience. The need for better training of pathologists is stressed, and interesting suggestions are made as to methods of carrying this out. The pathologist of the future is to be called on to state the degree of malignancy of a tumor, and whether or not it is radiosensitive. Malignancy, it should be remembered, is a clinical phenomenon—not a morphologic one. The clinician and the pathologist must be much better trained in the diagnosis of tumors than they are at present.

C. G. SUTHERLAND, M.D.

**Primary Carcinoma of the Lungs and Bronchi.** E. V. Goltz. *Minnesota Med.*, September, 1930, XIII, 605.

The increase in carcinoma of the lung is not wholly apparent, but there is evidence to show that it is actual. Primary carcinoma of the lungs may arise from the columnar epithelium of the bronchi, from the mucous glands of the bronchi, or from the squamous epithelium of the alveoli. The forms arising from the bronchial epithelium vary greatly in size, color, and consistency; they may remain as small local nodules, with wide metastases, or may grow extensively into the lung tissue. Sooner or later there is obstruction to a bron-

chus. The type arising from mucous glands is rare and usually limited to the walls and submucosa of the bronchi. Those types arising from the pulmonary alveolar epithelium may be diffuse over a large area, or may be multiple and nodular. Primary carcinoma of the lung is prone to metastasize. A careful history will usually focus attention on the lungs, when physical examination and special examinations by bronchoscope, by X-ray alone or after lipiodol injection will give conclusive evidence. The X-ray examinations should be repeated to observe progress. Therapy by X-ray may relieve pain, but progress of the lesion is rarely ever affected.

W. W. WATKINS, M.D.

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Some Notes on the Diagnosis of Carcinoma from the Blood Serum. Howard M. Jamieson. *Illinois Med. Jour.*, January, 1931, LIX, 40.

The writer gives a history of the various serological tests which have been used in an attempt to make an early diagnosis from blood serum. He has found a modified Botelho test most satisfactory.

The reagents used and the technic are as follows:

Reagent No. 1:

|                      |            |
|----------------------|------------|
| Formalin             | 1 c.c.     |
| Sodium citrate       | 0.25 gram  |
| Citric acid          | 4.74 grams |
| Pure iodine crystals | 1 gram     |
| Distilled water to   | 100 c.c.   |

Reagent No. 2:

|                      |          |
|----------------------|----------|
| Pure iodine crystals | 1 gram   |
| Potassium iodide     | 2 grams  |
| Distilled water to   | 210 c.c. |

The test is carried out by adding 0.25 c.c. of serum to be tested to a small test tube containing 2.0 c.c. of Reagent No. 1. Mix thoroughly without foam and add 0.7 c.c. of Reagent No. 2 slowly from a pipette. A flocculent precipitate forms which, in most cases, dissolves on thorough mixing (in all cases in which a normal or non-cancerous serum is being tested). A further 0.2 c.c. of Reagent No. 2 is added, forming a further precipitate

which persists after mixing, if the reaction is positive.

Reactions are graded as follows:

|                         |           |        |
|-------------------------|-----------|--------|
| Heavy precipitate after | 0.7 c.c.  | 4 plus |
| Light precipitate after | 0.7 c.c.  | 3 plus |
| Heavy precipitate after | 0.9 c.c.  | 2 plus |
| Light precipitate after | 0.9 c.c.  | 1 plus |
| No precipitate          | negative. |        |

All 1 plus reactions should be considered as doubtful, and should be repeated, with a new specimen of blood, if possible. The author believes a positive Botelho test, with an increased antitryptic index, especially if this be 3.0 or over, sufficient to warrant a diagnosis of cancer in any suspicious case.

He arrives at the following conclusions:

1. The most important thing in connection with cancer is an early diagnosis.

2. Of the several available tests, the most promising are the Botelho reaction and the antitrypsin index estimation used together.

3. Too much confidence should not be placed on either test used alone.

4. The Botelho test may be doubtful, but never really negative, in cases of cancer which have been treated with radium, while treatment by the X-ray does not seem to affect the reaction.

5. The reaction may be doubtful, but never really positive, in cases of syphilis treated with arsphenamine, but not in other methods of treatment. It may, however, be definitely positive in cases of degenerating gummas.

C. H. DEWITT, M.D.

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## CANCER (THERAPY)

The Present Status of the Treatment of Carcinoma of the Cervix Uteri. Erwin Zweifel. *Am. Jour. Obst. and Gynec.*, November, 1930, XX, 595.

The author comprehensively reviews the works and recommendations of various authorities on this subject, in both the fields of gynecology and radiology. The difficulty in appraising and comparing the relative cures obtained by the different methods, is cited. This difficulty is due to the personal equation entering into the grouping of the cases. The absolute cures are comparable, and he states that

the results in the best published statistics on treatment by irradiation are about the same as the results in the best published statistics for surgery.

The advantages enjoyed by irradiation are the absence of fear in the patient, resulting in earlier treatment; the low immediate mortality; its value in both operable and inoperable cases; the constant advancement and improvement in technic, while surgery has reached a *status quo*. The disadvantages of irradiation are the complications which may result even with the most careful technic just as in surgery, or inadequacy of the treatment. Proficiency in radiation therapy is more difficult to achieve than proficiency in surgery.

The treatments available are surgery, irradiation, or a combination of the two. Radiation therapy should always have a definite place in the plan of treatment for uterine carcinoma. The value of irradiation is conclusively demonstrated in the statistical reports of various authorities, in which their cures were doubled by routine post-operative irradiation over their cures by surgery alone, which include reports by Kroenig and Gauss, Warnekros, Zacherl and Lundwahl, Adler, Breitschneider, Giesecke, Lehotsky-Semmelweiss, and many others. The value of routine post-operative irradiation in carcinoma of other structures, as the ovary, breast, etc., has been conclusively demonstrated by Seitz and Wintz, Eymer, v. Franque, v. Jaschke, Strassmann, Schaefer, Breitschneider, Flatau, Aubert, E. Zweifel, Meyer, Buchholz, and others. Stoeckel combines pre-operative radium therapy, radical surgery, and post-operative roentgen therapy.

The author, a gynecologist, concludes that surgery and post-operative irradiation combined, give better results than surgery alone. The relative value of surgery and radium is not determined.

The discussions by Ward, Brettauer, v. Mikulicz, Healy, Stone, McGlinn, Taussig, Farrar, and Zweifel are well worth reading.

JACOB H. VASTINE, M.D.

with Various Combinations of Wave Lengths. Bernard P. Widmann and J. L. Weatherwax. *Am. Jour. Roentgenol. and Rad. Ther.*, November, 1930, XXIV, 540.

The authors are of the opinion that the progress of radium and roentgen therapy must depend upon the development of physical principles and technics which permit the delivery of greater quantities of radiation to the tumor areas. Clinical experience indicates that certain cancers are radiosensitive and radioresistant. Highly cellular cancers are extremely malignant and also highly radiosensitive. The authors maintain that the "skin erythema dose" should be standardized. They have found 800 r to be a safe erythema dose, from an experience of 15,000 doses of roentgen rays. Clinical results point to a selective action of gamma radium rays (with filtration equivalent of 2 millimeters of platinum). Combinations of different short wave lengths of roentgen rays, in conjunction with gamma radium packs to the same skin area, will increase the skin tolerance for radiations 30 or 40 per cent. Clinical impressions justify the inference of improved end-results in advanced cancer by the systematic application of combined short wave length radium and roentgen rays.

J. E. HABBE, M.D.

Modern Methods in the Treatment of Carcinoma. Fraser B. Gurd. *Canadian Med. Assn. Jour.*, December, 1930, XXIII, 784.

This paper is based on observations made during a somewhat prolonged trip to several of the more important British and European clinics.

Despite the fact that the injection into the body of certain colloidal substances, more especially lead and selenium, have been followed in a small number of cases by good results, the usefulness of such a procedure has been very problematical. During recent years there have been added to surgery, as means of combating cancer, three new methods, electrocoagulation, X-rays, and radium. Electrocoagulation has the advantage, as compared with the scalpel, of not running the risk of spread-

A Clinical Evaluation of Radium and Roentgen Therapy in Advanced Cancer,

ing cancer cells, and so has gained for itself a definite place in the attack on carcinoma.

The use of radium in the treatment of cancer has opened up an entirely new field. Special attention has been attracted to the subject since the publication of the work of Professor Forssell, of Stockholm. The Stockholm method of treatment of carcinoma, by means of radium and X-rays, differs from that practised in Paris and Brussels, and that used for the most part in London, in that larger doses of radium are employed for shorter periods.

In the treatment of skin cancers at Stockholm, the radium plaque is used for rodent ulcers. For other skin cancers, intubation is used. In the treatment of carcinoma of the lower lip, for instance, of the size of a ten-cent piece, five or six tubes, 1.5 cm. in length and containing 10 mg. of radium each, with a platinum-gold filtration equal to 1.0 mm. of lead, are inserted about and beneath the tumor. These are removed in from two and a half to four hours.

The Stockholm clinic is very enthusiastic about the use of the radium bomb or "telecurie therapy," as it is called in Paris and Brussels. They have two bombs, one containing from one to two grams of radium, and the other five grams. Radon is not used in Stockholm, chiefly, it would appear, because they believe it is dangerous for the technicians preparing the seeds or tubes.

Roentgen-ray therapy is extensively used, as is electrocoagulation, the latter especially in the case of mouth tumors and in carcinoma of the vulva. A common routine in the mouth tumors is, first, the X-ray, then electrocoagulation, and, at the same sitting, the insertion of radium tubes.

At Stockholm, in contrast with London, radium is not employed in carcinoma of the breast, except in cases of local or glandular recurrences. The routine treatment is one or two pre-operative courses of X-radiation, employing five ports of entry. The total dose over each port during each course is one or one and three-quarters of an erythema dose. Operation is undertaken six weeks after the last pre-operative radiation. Following operation, one, two, three, or sometimes four post-

operative radiations are carried out at intervals of from three to six months.

Buccal tumors are treated in Stockholm by means of electrocoagulation. In the anterior two-thirds of the tongue, the tissues immediately about the coagulated area are intubated with radium tubes.

They do not use radium in carcinoma of the rectum.

The most striking thing about the Stockholm clinic is the thorough organization for the protection of the operators as well as in the "follow-up" of the treatments. In Paris, the author found the work with radium much less organized for observation than that in either Stockholm or London, and, inasmuch as the work in London is largely based on that done in Paris, he believes it is better for the visitor to spend more time in London than in Paris. In London the treatment of carcinoma of the breast is carried out extensively by means of radium implantation. The work of Dr. Geoffrey Keynes, at St. Bartholomew's Hospital, and that of Dr. Stanford Cade, at Westminster Hospital, are specially mentioned. Dr. Cade has added to the method of implantation, that of distance radiation by means of radium in Columbia paste shields applied to the front and back of the chest. Cade, however, does not support the use of radium to the exclusion of surgery in the early cases. In London, they are not as enthusiastic about the use of the radium bomb as they are in Stockholm. The author does not believe the London technic in the use of the bomb is as good as that of Stockholm. At St. Bartholomew's Hospital both radium needles and radon seeds are used, but the physicians there believe the use of the needles is the better procedure.

In the treatment of carcinoma of the mouth, including the tongue, buccal mucosa, pharynx, and the palate, Cade depends entirely upon the use of radium and does not employ coagulation. In the treatment of the glandular areas, he uses block dissection of one or both sides of the neck, and follows with a radium collar after the wound is healed.

In the treatment of cancer of the rectum, Cade believes that ultimately a radium technic will be evolved which will be superior, but at

the present time surgery should be employed in the operable cases.

L. J. CARTER, M.D.

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**Cancer of the Breast.** Albert Soiland. *Jour. Cancer Research*, March, 1930, XIV, 128.

The writer is convinced that treatment of breast carcinoma in all stages would be effective if early radiation were instituted, regardless of whether or not surgery is undertaken. Post-operative radiation has probably added 10 per cent to the so-called clinical or five-year cure of all breast cases operated on. The author questions the value of several recent statistical reports showing five-year results in breast cancer obtained by surgery only, radiation alone, and by the combination of the two means. He feels that these reports are not fair to radiology, because the radiation therapy was not administered in many instances by those competent to do so in a scientific manner, and with adequate equipment. He feels that in the absence of any other apparent curative agent, radiation promises to become the active treatment factor in cancer of the breast, with surgery as an ally for general reconstructive work.

JOHN R. CARTY, M.D.

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**The Treatment of Carcinoma of the Tongue.** Milton Friedman. *Med. Jour. and Record*, Sept. 17, 1930, CXXXII, 284.

In planning the treatment of a case of carcinoma of the tongue, the therapist must first decide which objective to aim at: cure or palliation. Radiation is dangerous and either kills or cures, and only experience can teach one to differentiate between hopeless and favorable cases. In the preliminary treatment, external radiation by high voltage X-rays is directed to both sides of the neck, which should total four 25 per cent erythema doses to each side of the neck. If the tumor responds at all to this, the dose should be repeated before going on to local treatment. Interstitial radiation with radium needles is the best for local treatment. The author advocates platinum needles 27 and 35 mm. in length, each with 2 mg. of radium. These

should be inserted around the periphery of the lesion. Each needle should remain in place 100 hours, so that 200 milligram-hours may be delivered to each cylindrical area 1 cm. in circumference. The glands draining the tongue area should be thoroughly removed by surgical excision. If a persistent, painful radium scar or ulcer results, it should be excised with the endotherm knife.

W. W. WATKINS, M.D.

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**Diet of Carcinoma Patients.** W. Caspari. *Strahlentherapie*, 1930, XXXVII, 719.

The author discusses briefly the present status of our knowledge concerning the influence of diet on carcinoma in man. From a study of the literature, it appears that the diet must not be too rich. It should not be limited, however, so much that there is danger of under-nourishment. A few carbohydrates, fresh vegetables, and sugar are recommended; a certain amount of bread and some potatoes are permissible. Albumin and fat can be given freely. The desirable administration of Vitamin A is best carried out by feeding cod liver oil. Uncooked food is contra-indicated; large amounts of eggs and milk should be avoided; no liver or tomatoes should be given. Salt may be used according to the habits of the patient. This type of diet is meant for patients after operation or irradiation. Plenty of fluid should be taken first and then gradually reduced. A regular function of the bowels is very important.

ERNST A. POHLE, M.D., Ph.D.

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**The Radium Treatment of Cancer of the Tongue (Symposium).** Stanford Cade. *Canadian Med. Assn. Jour.*, December, 1930, XXIII, 771.

This symposium was contributed, at the meeting of the British Medical Association in Winnipeg, by Stanford Cade, of London; Douglas Quick, of New York, and G. E. Birkett, of Manchester. In many respects there was a remarkably close agreement among these three workers, and as a result there emerged a fairly authoritative declaration on the radium treatment of buccal carcinoma.

For treatment of the primary growth all were

agreed on the advantages of radiation over surgery, but whereas Cade and Birkett favored radium needles, Quick preferred radon seeds. In the opinion of the first two authorities it was difficult, with seeds, to obtain a uniform intensity of radiation, not only because the intensity of radiation rapidly diminished within a period of four days, but also because the small seeds could not be so accurately placed as the larger needles.

For the treatment of operable metastases of the neck, all the speakers favored free surgical excision. When there were large inoperable metastases the glands should be actively treated by radium needles in large doses, and the balance of opinion favored open operation as the method by which this should be carried out. For early cases in which no palpable metastases could be found there was sharp divergence of opinion as to the method of treatment to be employed. Birkett advocated a waiting policy, provided the patient reported for examination once a month. Cade and Quick, on the other hand, believed that the neck should never go untreated. Cade advocated treatment by needling, using the closed method, or external treatment by means of the radium collar. Quick employed heavily filtered high voltage X-radiation, and more recently a 4-gram radium element pack. Speaking of the radium bomb at the Westminster Hospital, Cade felt that it was not an economical method of using radium. Quick stressed the importance of cleaning the mouth before treatment was begun. The general impression given out was that radium was superior to surgery alone.

L. J. CARTER, M.D.

**Carcinoma of the Cervix Uteri.** Cornelius Oliver Bailey. *Texas St. Jour. Med.*, September, 1930, XXVI, 351.

Since 30 per cent of cancer in the female involves the uterus, and 90 per cent of uterine cancer originates in the cervix, the consideration of this lesion is of great importance. The earliest stages of the disease appear as (1) a hard nodule in the substance of the cervical lip, (2) papillary outgrowths from the lip or the canal, or (3) excavation or cauliflower growth.

Cervical cancer involves the pelvic nodes in less than one-third of the cases. The treatment of cancer is both educational and technical. From the technical standpoint, there is a two-fold problem: (1) eradication of the local lesion and maintenance of body resistance at the highest point of efficiency; (2) the study of the general condition of the patient in order that the natural body resistance to cancer may be kept at the highest point of efficiency. The treatment and prognosis are largely dependent on intelligent study of the biopsy specimen, and no line of treatment is justified until a pathological report is available. The method of treatment advocated is usually from four to six thousand milligram-hours of heavily filtered radium to the cervix and broad ligament regions. This is supplemented with medium wave roentgen-ray therapy in massive doses over the pelvis by "cross-fire" distribution. After this a "follow-up" system is essential to the proper handling of the cases.

W. W. WATKINS, M.D.

**Factors Influencing the Treatment of Rectal Cancer.** George E. Binkley. *Jour. Am. Med. Assn.*, Dec. 27, 1930, XCV, 1971.

The treatment of rectal cancer is a perplexing but interesting problem, on account of the variable factors associated with this disease at the time a definite diagnosis is determined. Early recognition of rectal cancer, while the tumor is small and the disease is localized, offers many advantages to successful treatment. The two methods of treatment that have proved of greatest value in this disease are radiation therapy and surgery. In a miscellaneous group the best results are obtained by varying the dosage and technic in accordance with the clinical and pathological features of the given case.

The two forms of radiation therapy that have proved of greatest value in deep-seated tumors are external applications of radium and roentgen rays, and interstitial applications of radon, filtered by 3 mm. of gold. The surgical procedures that offer the greatest possibilities are the abdomino-perineal and the perineal types of operation, while a colostomy affords a certain degree of palliation in the

inoperable group. It appears more appropriate now to classify cases as favorable and unfavorable. Favorable patients are those presenting strong possibilities of being rendered free from disease by surgery, radiation therapy, or the combined use of radium and surgery. Unfavorable patients are those suited only for palliative measures. The physical condition of the patient should receive primary consideration, as the severity of the treatment should not exceed his endurance. Moreover, the degree of palliation in the unfavorable group frequently depends upon the physical condition. The anatomic location and the accessibility of the cancer within the rectum may greatly influence the selection of treatment. Through recognition of the type of malignancy before treatment is undertaken, many patients with incurable, highly malignant cancers will be saved the unnecessary annoyance of radical procedures. On the other hand, patients with tumors of the lowest degrees of malignancy will be rendered free from disease or provided with the highest degree of palliation. The grade of malignancy suggests a solution of the problem in determining the most appropriate type of operation. A moderate sized, low-grade rectal cancer, in which the disease appears to be more or less localized, may be completely eradicated by surgical dissection, while a similar surgical procedure in the case of a tumor of the highest grade of malignancy, but similar in size and fixation, is more likely to be detrimental than beneficial. Highly malignant tumors are cellular and usually radio-sensitive and require a comparatively small dosage. Overdose in this type tends to produce necrosis and sloughing. In certain instances the employment of interstitial irradiation is contra-indicated. Tumors of low-grade malignancy lend themselves well to interstitial irradiation, although they require for devitalization a comparatively large dosage of gold seeds. Cancers occurring in patients below the age of 30 are usually highly malignant.

A long history of mild subjective and objective symptoms, associated with a comparatively small tumor, without deep infiltration, suggests a low malignancy, while a sudden

onset of severe symptoms, accompanied by a comparatively extensive mass, indicates a more highly active process. The most adequate determination is by the combined application of the clinical and histologic studies.

CHARLES G. SUTHERLAND, M.D.

**Cancer of the Esophagus: Analysis of Eighty-two Cases.** E. P. McCullagh. *Med. Jour. and Record*, Sept. 17, 1930, CXXXII, 288.

This study includes 82 cases seen at the Cleveland Clinic for the period from 1921 to 1928. Of these, 77 per cent were men, the average age being 59 years. No patient recovered, the average duration of life in men being 9.9 months and in women 12.5 months. Fifty-seven patients received some sort of treatment.

In 92 per cent of 74 cases in which an X-ray examination was made, a positive diagnosis of cancer of the esophagus was made. In 9 cases the examination failed to show the lesion on the first examination; in 2, a second examination identified it. One case, positive on X-ray examination, was negative to esophagoscopy, but was found to be positive three months later. Cardiospasm was diagnosed by esophagoscopy in one case, while the X-ray revealed a definite growth one month later. Fifty-seven patients received some sort of treatment; X-ray was employed in 14 cases, radium in 16, gastrostomy in 17, dilatation in 7, and esophagectomy in 3.

Surgical removal of cancer of the esophagus is a formidable procedure and hardly justified. The best treatment is the application of radium through an esophagoscope, and this does little good. A few cases have been reported as benefited by the X-ray.

W. W. WATKINS, M.D.

**Present Methods of Radiation Treatment of Carcinoma and Their Results. III.—The Saturation Method of Pfahler and Kingery.** Hans Holfelder. *Strahlentherapie*, 1930, XXXVII, 696.

The principles of the saturation methods as advocated by Kingery and Pfahler are briefly discussed. One of the author's assistants studied the skin reactions following exposure



to roentgen rays by using different intervals. The preliminary results are given and illustrated by two photographs of the irradiated skin.

ERNST A. POHLE, M.D., Ph.D.

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**The Treatment of Carcinoma of the Body of the Uterus.** William Neill, Jr. *Am. Jour. Roentgenol. and Rad. Ther.*, October, 1930, XXIV, 412.

Adenocarcinoma of the body of the uterus is rarer than cervical cancer, grows more slowly, and tends to remain restricted to its primary corporal origin. Metastases to distant or neighboring structures, however, are more common than in the cervical group. In this paper the author emphasizes his treatment of this disease with radium, reporting results and the percentage of five-year cures. Taking all groups treated at the clinic prior to five years ago, there were 109 patients; 76 have died, counting 6 patients lost sight of as dead, and 33 are living, making a total five-year-cure rate of 33 per cent. The author does not attempt a prognosis from the standpoint of histological grading. He concludes that, as with cancer elsewhere, the greatest hope for cure lies in an early diagnosis. In operable carcinoma of the body of the uterus, radium offers a method of treatment comparable to surgery, as it obviates the primary mortality and can be used safely in those cases presenting bad surgical risks—it offers the possibility of a cure or definite palliation to a number of inoperable and recurrent cases. When there is any doubt as to the extent of the disease, operation alone or operation combined with radium therapy is the treatment of choice.

J. E. HABBE, M.D.

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**The Principles of and Some Results in the Radium Treatment of Buccal Carcinoma.** G. E. Birkett. *Canadian Med. Assn. Jour.*, December, 1930, XXIII, 780.

This paper is the final contribution toward the symposium on radium therapy in cancer of the tongue, abstracted on page 587.

Radium has improved out of all recognition the outlook in buccal carcinoma. All squamous epitheliomas of the mouth and

tongue are radiosensitive, some more so than others, and there is now unanimity of opinion that prolonged irradiation with gamma rays of low intensity yields the best results. The problem, then, should be mainly one of the insertion or application of the radium. The author is unhesitatingly in favor of using radium needles in preference to seeds.

Metastasis to the cervical glands, which always occurs by embolism, cannot be adequately treated either by external radiation or by blind insertion of needles through the skin. The author's practice is to reflect flaps, as in a block dissection of the neck, divide the sternomastoid, and insert needles in the anterior and posterior triangles about 2 cm. apart. These are left in position about eight days.

The results of treatment in the author's series of cases is as follows: 38.7 per cent 3-year "apparent cures"; 47.3 per cent 2-year, and 60 per cent 1-year, for the primary site. When the primary and secondary sites are considered, the percentages are 27.5, 36, and 45, respectively. Improvement in results will depend on several factors: the two most important are earlier diagnosis and concentration of radium treatment at larger centers.

L. J. CARTER, M.D.

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**Malignancy of the Body of the Uterus.** O. L. Norsworthy. *Texas State Jour. Med.*, October, 1930, XXVI, 440.

In a series of 264 cases of cancer of the uterus examined from 1921 to 1928, 42 were corpus cases, two of which were sarcoma, two were chorio-epithelioma, the others being the usual adenocarcinoma. Of these, 27 were treated with radium alone, and 15 with radium and hysterectomy. Of the 27 patients treated with radium, 11 are living and well five years after treatment; of the 15 treated by radium and hysterectomy, five are living and well at the end of five years. While 42 is not a large enough series from which to draw conclusions, the number suggests that irradiation may become the treatment of choice for malignancy of the body, just as it has in malignancy of the cervix.

W. W. WATKINS, M.D.

Treatment of Intra-oral Cancer, with Special Reference to Radium Therapy. Douglas Quick. New York St. Jour. Med., Sept. 15, 1930, XXX, 1094.

Practically all our experience with radium has been gained during the past fifteen years, and a certain number of failures during this period must be charged up to the accumulation of experience. Surface applications were first used, but were discontinued as far back as 1917, with only three cases in which complete and permanent regression of the disease was obtained. From 1917 to 1925 results improved through the use of unfiltered emanation seeds. In 1925, these were replaced by the gold emanation tubes which filter all the softer rays, lessening the local reaction, pain, and necrosis.

The treatment of intra-oral cancer is a surgical problem and must be approached as such. The radium irradiation is the backbone of treatment of intra-oral cancer. Radium must be accurately placed and with accurate dosage, and other associated measures must be used. X-radiation is a necessary complement in all cases of intra-oral cancer, unless large amounts of radium are available for distance radiation. Operative surgery is frequently necessary in the mouth for drainage, for access to growth, and for dealing with disease in bone; also in the neck in early, definite involvement of adult epidermoid carcinoma. Four hundred and seventy-three cases of cancer of the tongue are reported upon, of which 22.4 per cent were clinically free from disease for from five to ten years after treatment.

W. W. WATKINS, M.D.

Uranium-thorium Colloid in the Treatment of Carcinoma. George T. Pack and Fred W. Stewart. Jour. Cancer Research, March, 1930, XIV, 152.

The authors administered a mixed uranium-thorium colloid intravenously to eight patients with advanced carcinoma, according to the method of Hocking. There was evidence of temporary benefit in one case. In the other seven cases there were no signs of improvement of any sort. In two patients, there was

evidence of kidney damage, although no autopsy confirmation was obtained. Autopsy was done upon two cases. The Kupffer cells of the liver showed the usual type of liver picture seen with many colloid metals. The spleen showed phagocytic material in the reticulo-endothelial apparatus. Desiccated liver and spleen were found to be radio-active, but the tumor tissue from the same cases showed no evidence of radio-activity.

JOHN R. CARTY, M.D.

Radium Treatment of Cancer of the Tongue. Stanford Cade. Canadian Med. Assn. Jour., December, 1930, XXIII, 771.

This paper is a contribution toward the symposium on radium therapy in cancer of the tongue, abstracted on page 587.

In the last few years this form of therapy has made rapid strides, following the results obtained by Regaud, who introduced the method of needling, now in most general use. In the series of cases under review, all were treated except those with a life-expectancy of only a few weeks. No attempt is made to separate the operable from the inoperable group.

All the cases were treated by implantation of radium needles into and around the tumor, seeds being used exceptionally when local conditions demanded them. The needles used contained 0.6 mg. and 1.3 mg. of radium, and were fully screened by 0.5 mm. and 0.6 mm. of platinum, respectively. The period of treatment was seven days. The amount of radium used depended on the extent of the disease. Treatment of the primary lesion was nearly always followed by treatment of the lymphatic area in the neck, either by needling through the closed method or by use of a radium collar.

The cases treated cover a period of five years, from April, 1925, to April, 1930. The total number was 253, distributed as follows: tongue, 169; cheek, 23; tonsil, 12; palate, 28; lip, 21.

Disappearance of the primary lesion was obtained in 126 cases, that is, 74 per cent. The number of local recurrences, as distinguished from primary failures, was 43, that

is, 25 per cent. In many of these latter the lesion was completely eradicated by subsequent treatment. The percentage of cases requiring a second treatment was definitely greater among those treated by radon seeds than among those treated by needles.

The main conclusions reached are: (1) the superiority of needles, and (2) the necessity of treating *all* cases over the cervical gland area. Here needling by either the closed or open method is preferred to surface application.

L. J. CARTER, M.D.

**Radium and Surgery in Cancer of the Tongue.** Douglas Quick. *Canadian Med. Assn. Jour.*, December, 1930, XXIII, 774.

This paper is another contribution to the symposium on radium therapy in cancer of the tongue, abstracted on page 587.

Two points are emphasized: (1) that the combined use of radiation and operative surgery offers several advantages in the treatment of epidermoid carcinoma in general, and (2) the treatment of epidermoid carcinoma is steadily approaching a more reasonable, accurate, and efficient basis.

Histologic study of the relative degrees of cell differentiation or potential malignancy of tumor processes has been most enlightening from the therapeutic standpoint. It shows very clearly the reason for surgical failure in many instances, and at the same time explains some of the most spectacular reactions to radiation. The undifferentiated growth, highly malignant, prone to early and widespread dissemination through both lymphatics and blood stream, presents obviously a poor surgical risk. On the other hand, it is highly radiosensitive. The fully differentiated tumor process is more orderly in its development. Metastasis occurs, as a rule, later in the disease, and even then tends to remain within a limited area. In such cases it is but reasonable to expect relatively better results from operative measures. The more adult the growth the more radioresistant it becomes. The reaction to radiation is not nearly so spectacular, and yet, if the process be controlled by this means, the

assurance of permanency of the result is much greater.

Martin and Quimby have shown that adult epidermoid carcinoma requires from seven to ten erythema doses throughout the tumor-bearing area to produce complete and permanent control of the growth. The anaplastic growths, on the other hand, respond completely to a dosage range of from three to six skin erythemas, depending on the relative degree of differentiation.

As three skin erythema doses is the safety limit for safe irradiation of the tongue by external methods, it is evident that this must be supplemented by some means in the case of growths showing any degree of cell differentiation. Interstitial radiation must be employed.

Inasmuch, then, as treatment detail is based on the histology of the growth it is essential that a biopsy be done early and in all cases. The theoretical objections to this procedure are overridden by the advantages of the information obtained.

Oral hygienic measures are of prime importance.

In the Memorial Hospital the same principles of treatment are followed as presented before the First International Congress of Radiology in London, 1925, and published in the *British Journal of Radiology*, March, 1926. External radiation of greater intensity than formerly employed is now being used, augmented recently by a radium pack of 4 grams. For interstitial radiation, radium emanation, or radon, in gold capillary tubes, with a filtration of 0.3 mm. gold, is employed.

If the growth be bulky, fungating, and markedly infected, the implantation is followed in a few days by cautery removal of the condemned area.

Secondary invasion of bone by growth, infection in bone, or devitalized bone caused by irradiation, calls for surgical removal.

The treatment of the lymph nodes in the neck consists of heavily filtered external radiation of the maximum intensity consistent with tissue tolerance, and from both sides. If a palpable node of adult type epidermoid carcinoma is present, complete unilateral dissec-

tion is done under local anesthesia. Before the wound is closed, filtered radon seeds are implanted at any suspicious points. No post-operative radiation is employed. If the node is inoperable, no dissection is attempted, but radon seeds are implanted. All necks with bilateral metastatic nodes are regarded as being surgically inoperable, and incurable except in very rare instances. External radiation is used as a palliative measure only in these advanced cases. Metastatic nodes from anaplastic epidermoid carcinoma are treated by radium alone, used externally in most instances, but supplemented by implantation of radon tubes.

An analysis of ten-year clinical results is appended.

L. J. CARTER, M.D.

### CHEMICAL<sup>1</sup>

The Crystal Structure of Silver Cyanide. H. Braekken. Kgl. Norske Videnskabers Selskab., Trondhjem, Forhandlinger, v. 2, 1929, II, Medd. No. 48, 169.

AgCN recrystallized from  $\text{Na}_2\text{CO}_3$  or  $\text{K}_2\text{CO}_3$  solutions showed the same diffraction pattern as the original powdered material. The crystals were needles, 3–4 mm. in length, and showed prisms of the first order, though a few with second-order prisms were found. The crystals are of the hexagonal quadratic form. Laue photographs show a ditrigonal roentgen symmetry. The parameter is 4.60 Å.U. and the angle  $81^\circ 14'$ . The space group is  $C_3^2$ . Ag ions are located 3.5 Å.U. from C or N. The forces are strongest in the direction of the needle axis. Braekken proposes to call this type a chain lattice, a linear analog of layer lattices.

CHEMICAL ABSTRACTS.

Structure Produced by Rolling of Metals. E. Schmid and G. Wassermann. Metallwirtschaft, 1930, IX, 698.

A piece of technical sheet zinc was cold-rolled in one direction to a thickness of 0.02 mm. and X-ray photographs taken at various angles to the sheet in three planes: (1) in the

direction of rolling, (2) perpendicular to and (3) at an angle of  $45^\circ$  to the direction of rolling. The photographs are summarized in a pole diagram showing the position and the intensity of the base faces. The same procedure was followed with a piece of magnesium annealed 1.5 hours at  $600^\circ$  and cold-rolled to 0.03 millimeter. The orientation of Mg is much simpler than that of Zn. The formation of the orientation of the two metals is explained by the changes in the single crystal, and the characteristic difference by the difference in the mechanical twinning. The heterogeneity of the orientation of rolled Zn is proved by preliminary tests.

CHEMICAL ABSTRACTS.

X-ray Study of Certain Esters of Cellulose and of Glucose. A. Nowakowski. Compt. rend., 1930, CXCI, 411.

Distearic and dilauric esters of cellulose showed only a microcrystalline structure, and no fiber pattern; but fiber patterns were obtained from pentacetic, pentalauric, and pentapalmitic esters of glucose, with an identity period along the fiber axis 5.28–5.39 Ångström units. The fibrous forms of these esters have fibers all in the same direction, with the aliphatic acid chains at right-angles to the length of the fiber.

CHEMICAL ABSTRACTS.

False Lines in X-ray Grating Spectra. J. M. Cork. Phys. Rev., Aug. 15, 1930, XXXVI, 665.

Certain false lines may be obtained on the photographic plate in addition to those due to defects in the grating because of the generally employed arrangement of slits, X-ray source, and diffraction grating in X-ray spectroscopy.

CHEMICAL ABSTRACTS.

Orientations of the Molecules in Naphthalene and Anthracene Crystals. Kedareswar Banerjee. Indian Jour. Physics, 1930, IV, 557 (cf. Chem. Abs., XXIV, 3410).

It has been found that the intensities of X-ray diffraction from naphthalene and anthracene crystals do not conform to the ori-

<sup>1</sup>Reprinted by permission from *Chemical Abstracts*.

entations of the molecules along any cell face. By the "trial and error" method of analysis it has been found that the molecules are inclined to the cell faces, the correct positions being obtained by first placing them along the plane and then by two successive rotations about the "b" and the "c" axes. The rotations about the "b" axis for the two molecules in the unit cell are equal but opposite, while about "c" they are in the same direction in conformity with the space-group  $C_{2h}^2$ . The amounts of rotations for naphthalene are  $25^\circ$  and  $12^\circ$ , respectively, and those for anthracene are  $25^\circ$  and  $9^\circ$ . All the benzene rings in the same molecules are in the same plane and the rings are practically regular hexagons. The structure obtained, as the result of the present investigations, is in conformity with the magnetic and optical properties of these crystals.

#### CHEMICAL ABSTRACTS.

Polymorphism of Sodium Sulfate. IV.—X-ray Analysis. F. C. Kracek and C. J. Ksanda. Jour. Phys. Chem., 1930, XXXIV, 1741.

Three forms of  $\text{Na}_2\text{SO}_4$  were detected:  $\text{Na}_2\text{SO}_4$  I, stable  $240^\circ$ ;  $\text{Na}_2\text{SO}_4$  V, stable at ordinary temperatures, and  $\text{Na}_2\text{SO}_4$  III, metastable below  $185^\circ$  but inert, when dry, at ordinary temperatures. X-ray patterns of the three forms and also of  $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$  are presented.

#### CHEMICAL ABSTRACTS.

Liquid Structure and X-ray Diffraction in Liquids. Kedareswar Banerjee. Indian Jour. Physics, 1930, IV, 541.

A theoretical explanation of X-ray diffraction effects in liquids is presented, consisting essentially of the application of the Boltzmann principle, as originally employed by Raman and Ramanathan, to analyze liquid structure. The method is modified so as to take into account the nature of the field of force surrounding the molecules. The intensity distribution in the diffraction pattern is worked out. The liquid structure is a degeneration of the crystal structure brought about by the thermal agitations, and hence some of the intense crystal diffraction lines give rise to liq-

uid diffraction maxima while others are quenched out. Simple cases of Na, K, A. and Hg are discussed fully and found to agree with the experimental results. Intensity distribution for rays diffracted by Hg is calculated according to theory and found to agree with the photographs given by Prins.

#### CHEMICAL ABSTRACTS.

The Crystal Lattice of Iron Silicide,  $\text{FeSi}$ . H. Möller. Naturwissenschaften, 1930, XVIII, 734.

The results of Phragmen (Chem. Abs., XVIII, 3032) were verified. The compound was prepared from 33.0 g. Armco Fe and 17.0 g. Si in a Pythagoras crucible. Tammann furnace. Debye-Scherrer diagrams were made and measured. They gave a cubical translation lattice  $T_c$  with  $a = 4.467 \text{ \AA.U.}$  From this and  $d. = 6.23$  it follows that there are 4  $\text{FeSi}$  in the unit cell. Only space group  $T^4$  with Fe in  $(uuu)$ ,  $(u + \frac{1}{2}\bar{u} + \frac{1}{2}\bar{u})$ ,  $(u + \frac{1}{2}\bar{u} + \frac{1}{2})$ ,  $(\bar{u} + \frac{1}{2}\bar{u} + \frac{1}{2})$  and Si in  $(vvv)$ ,  $(v + \frac{1}{2}\bar{v} + \frac{1}{2}\bar{v})$ ,  $(\bar{v} + \frac{1}{2}\bar{v} + \frac{1}{2})$ ,  $\bar{v} + \frac{1}{2} - \bar{v} + \frac{1}{2}$  corresponds to the intensities measured,  $u = 0.1340 \pm 0.0020$ ,  $\bar{v} = 0.8445 \pm 0.0020$ . The distances of Fe and Si are 2.24, 2.34, and 2.52  $\text{\AA.U.}$ , min. for Fe-Fe 2.74  $\text{\AA.U.}$ , Si-Si 2.76  $\text{\AA.U.}$

#### CHEMICAL ABSTRACTS.

Absorption of X-rays by Lithium. K. C. Mazumder. Phys. Rev., 1930, XXXVI, 347.

The mass scattering coefficient of lithium was measured for wave lengths 0.587–0.100  $\text{\AA.U.}$  For longer wave lengths the results can be expressed by the equation  $\mu/\rho = 0.94\lambda^3 + 0.162$ . Below 0.2  $\text{\AA.U.}$  there is a very rapid bending of the curve towards the axis  $\lambda^3$ .

#### CHEMICAL ABSTRACTS.

X-ray Diffraction in Liquid Hexamethylbenzene. P. Krishnamurti. Indian Jour. Physics, 1930, IV, 449.

The liquid X-ray pattern consists of a strong inner halo (8.2  $\text{\AA.U.}$ ) and a weak outer one (4.2  $\text{\AA.U.}$ ), corresponding roughly to the [100] and [001] reflections of the crystal powder (7.7  $\text{\AA.U.}$ ; 3.7  $\text{\AA.U.}$ ). It is assumed

that the 4.2 Å.U. spacing of the liquid is caused by the thickness of the molecule; the other spacing represents periodicities in the plane of the benzene ring. The diminished structure-factor for the [001] spacing caused by the thermal agitation of the molecules in the liquid causes a diminution in intensity of the outer halo in the liquid. The outer rings of other benzene derivatives correspond to the thickness of the molecule.

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CHEMICAL ABSTRACTS.

The Crystalline Structure of Hydrogen Sulfide and Hydrogen Selenide (II). G. Natta. *Atti accad. Lincei*, 1930, XI, 749; cf. *Chem. Abs.*, XXIV, 4973.

The structures of  $\text{H}_2\text{S}$  and  $\text{H}_2\text{Se}$  were studied on crystallized material by means of X-rays. At  $-170^\circ$ ,  $\text{H}_2\text{S}$  has a cubic unicellular space lattice,  $5.778 \pm 0.003$  Å.U. on a side; volume  $192.8 \times 10^{-24}$  c.c.; containing 4 molecules of  $\text{H}_2\text{S}$ ; density (calculated) 1.166.  $\text{H}_2\text{Se}$  also has a cubic structure containing 4 molecules, side  $6.020 \pm 0.005$  Å.U.; volume  $218.2 \times 10^{-24}$  c.c.; density (calculated) 2.456.

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CHEMICAL ABSTRACTS.

The Crystal Structure of Cadmium Chloride. Linus Pauling and J. L. Hoard. *Ztschr. f. Krist.*, 1930, LXXIV, 546 (in English).

The unit of structure for  $\text{CdCl}_2$  is a rhombohedron, with  $\alpha = 36^\circ 02'$  and  $a = 6.23$  Å.U. containing 1 molecule. There is a layer structure along [0001], closely related to that of  $\text{CdI}_2$ . The Cl atoms are in approximate cubic close-packing. The relation of the  $\text{CdCl}_2$  and the  $\text{CdI}_2$  structures is discussed, and a list of similar compounds which crystallize in each type is given.

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CHEMICAL ABSTRACTS.

The Absorption of Long Wave X-rays of 2-10 Å.U. in Light Elements. Bernhard Woernle. *Ann. Physik* [5], 1930, V, 475.

This reports experimental determinations of the absorption coefficient of air, N, O, Ne,

A,  $\text{SO}_2$ ,  $\text{C}_2\text{H}_{12}$  vapors and  $\text{CCl}_4$  vapors in the range 2.3-9.9 Å.U., by means of a vacuum ionization spectrometer. A null method was used. From the experimental data, the coefficients of S, C, and Cl have been computed. The electronic absorption coefficient is not strictly a pure function of the product  $Z\lambda$ , systematic deviations being observed. The  $K$  level absorption energy change was found for S, Cl, and A, and was approximately equal to the ration of the energy values of the  $K$  and  $L$  levels.

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CHEMICAL ABSTRACTS.

Scattering of X-rays by Bound Electrons. Saligram Bhargava. *Nature*, Sept. 13, 1930, CXXVI, 398.

Bhargava attributes the scattering noted by Dr. B. B. Ray (cf. *Chem. Abs.*, XXIV, 3705) to a special case of photo-electric emission. A beam of frequency  $\nu$  hitting a  $K$  electron loses energy equal to  $h\nu_k$  and will retain  $h(\nu - \nu_k)$  which may either continue, or be absorbed by the electron which is then ejected. This has been used by de Broglie and Robinson to obtain the energy levels of atoms. Dr. B. B. Ray, in *Nature*, Sept. 13, 1930, CXXVI, 399 (cf. *Chem. Abs.*, XXIV, 4213): The lines previously described as "modified lines due to the scattering of X-rays by bound electrons," would be better described as due to partial absorption of incident radiation by atoms. Further lines observed are given.

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CHEMICAL ABSTRACTS.

X-ray Examination of Gelatin Micelles. W. Abitz, O. Gerngross, and K. Herrmann. *Naturwissenschaften*, 1930, XVIII, 754.

The work of Katz and Gerngross has shown that gelatin gives a partly amorphous, partly crystalline X-ray diagram; stretched gelatin gives a collagen-like diagram. It appears on careful stretching that these diagrams are inter-related. The structure of gelatin is deduced in a manner similar to that for liquid crystals (Glamann, Herrmann, and Krummacher, *Chem. Abs.*, XXIV, 4438) on the basis of parallel long stretched molecules. The polypeptide chains are arranged parallel to

each other over part of their length, thus giving an almost crystalline structure, without strict identity of the units. The ends of the chains are not closely bound together, so that the micelles appear more or less "frayed," causing the amorphous part of the X-ray diagram. The "frayed" ends of the chains produce the intermicellary coherence of the gelatin. Greater orientation and coherence of the chains and fewer "frayed" ends are found in collagen and in stretched gelatin. By the structure described several of the properties of the substance are explained.

#### CHEMICAL ABSTRACTS.

The Chemical and Crystalline Structure of Several Complex Nitrites. A. Ferrari and C. Colla. *Atti accad. Lincei*, 1930, XI, 755; cf. *Giorn. chim. ind. applicata*, 1930, XII, 142.

The three nitrites  $K_2PbNi(NO_2)_6$ ,  $K_2PbCo(NO_2)_6$ , and  $K_2PbCu(NO_2)_6$  have similar cubic crystal structures, having 4 molecules for unit cell, and the sides and diameters are, respectively, 10.55, 10.49, 10.52 Å.U.; 3.5, 3.66, 3.56.  $2 K_3Co(NO_2)_6 \cdot 3H_2O$  has a similar cubic structure with 4 molecules, and side 10.32 Å.U. Probably there is no water of crystallization, the  $H_2O$  being enclosed in the space lattice, rather than held by the molecule itself.

#### CHEMICAL ABSTRACTS.

The Crystal Structure of the Normal Paraffins at Temperatures Ranging from that of Liquid Air to the Melting Points. Alex Müller. *Proc. Roy. Soc., London*, 1930, CXXVII-A, 417.

An X-ray investigation has been made of the structures of a number of normal paraffins ranging from pentane to triacontane, at liquid-air temperature, atmospheric temperature, and near the melting points. Linear expansion measurements show that the lengths of both the  $a$  and  $b$  axes increase considerably with rise of temperature, the coefficient of expansion of the  $a$  axis being three or four times as large as that of the  $b$  axis. The expansion of the  $c$  axis is very much smaller, and does

not exceed 0.1 of that of the  $a$  axis. These facts indicate that the forces which hold the atoms together in the molecule are different in magnitude from those which keep the molecules apart from each other; the chemical conception of the entity of the molecule is thus confirmed for the solid state. The higher members of the paraffin series crystallize in the so-called "normal" form previously described (Müller and Saville, *Chem. Abs.*, XIX, 1692) which is found to be stable between the melting point and liquid-air temperature. Differences in the behavior of the odd and even members begin to appear as the number of C atoms decreases, docosane and lower members existing in two alternative forms. Within a small range of temperatures near the melting point the normal form is stable, but at lower temperatures a second crystal structure appears and persists down to the temperature of liquid air. The change from one form to the other is reversible for docosane, eicosane, and octadecane. The change from the normal to the other form occurs between undecane and nonane in the series of the odd members. These abrupt changes in structure are discussed and a qualitative explanation is suggested. Observations taken in the immediate neighborhood of the melting point indicate that these substances tend to form layer structures, and it is shown how the normal form could be transformed into such a structure in a simple manner.

#### CHEMICAL ABSTRACTS.

Crystal Structure of Normal Paraffins. S. H. Piper and T. Malkin. *Nature*, 1930, CXXVI, 278.

Very pure specimens of four of the higher normal paraffins were classified according to Müller (preceding abstract). Hexacosane,  $C_{26}H_{54}$  and tetratriacontane,  $C_{34}H_{70}$ , exist in two stable forms at room temperature, one with the normal  $A$  spacing, and the other about 4 Å.U. shorter, but obviously not the  $B$  "second form." Hexacosane took the  $C$  form when crystallized from  $C_6H_6$  or EtOH, while a melted layer showed both  $A$  and  $C$  spacings. Tetratriacontane from  $C_6H_6$  gave only  $C$  spacings, while melted crystals showed only

the *A* form. Triacotane,  $C_{30}H_{62}$ , showed the *A* form under all conditions. Even-numbered hydrocarbons of 26 or more C atoms seem to crystallize in the *C* form, while the odd-numbered nonacosane,  $C_{29}H_{60}$ , crystallizes in the *A* form. This alteration of crystal habit is in accord with the behavior of the normal aliphatic acids and alcs.

#### CHEMICAL ABSTRACTS.

**The Crystal Structure of Cementite.** Sterling B. Hendricks. *Ztschr. f. Krist.*, 1930, LXXIV, 534 (in English).

From data published by Westgren and Phragmen (*Chem. Abs.*, XVI, 2291; XVIII, 2093), a complete structure determination is made for  $Fe_3C$ . The space group is  $P_h^{16}$ . Atomic positions are derived. The structure is of the co-ordination type.

#### CHEMICAL ABSTRACTS.

**The Crystal Structure of  $Fe_2P$ ,  $Fe_2N$ ,  $Fe_3N$ , and  $FeB$ .** Sterling B. Hendricks and Peter R. Kosting. *Ztschr. f. Krist.*, 1930, LXXIV, 511.

Examination of published data for  $Fe_2P$ ,  $Fe_3N$ ,  $Fe_2N$ , and  $FeB$  show that these compounds have a non-ionic co-ordination type of structure (cf. preceding abstract).  $Fe_3N$  (cf. *Chem. Abs.*, XXIII, 2408, 4387) is hexagonal with N at 000;  $\frac{1}{3}$ ,  $\frac{2}{3}$ ,  $\frac{1}{2}$ ; and Fe at 0,  $\frac{1}{3}$ ,  $\frac{1}{4}$ ; 0,  $\frac{2}{3}$ ,  $\frac{3}{4}$ ;  $\frac{1}{3}$ , 0,  $\frac{1}{4}$ ;  $\frac{2}{3}$ , 0,  $\frac{3}{4}$ ;  $\frac{1}{3}$ ,  $\frac{1}{3}$ ,  $\frac{3}{4}$ ; and  $\frac{2}{3}$ ,  $\frac{2}{3}$ ,  $\frac{1}{4}$ . The unit cell contains 2 molecules and  $a = 2.695 \sqrt{3}$ ,  $c = 4.362$  Å.U. For  $Fe_2N$  the Fe atoms have the same positions as in  $Fe_3N$ , while N is at 000;  $\frac{1}{3}$ ,  $\frac{2}{3}$ , 0;  $\frac{2}{3}$ ,  $\frac{1}{3}$ ,  $\frac{1}{2}$ . Atomic positions are derived for  $Fe_2P$  and  $FeB$ . For compounds of this type a polyhedron of metal atoms is formed around each non-metallic atom, the former equidistant from the latter. The polyhedra are regular or distorted, so that the metal atoms have, along some elements, approximately the separation characteristic of the metal. If a compound  $R_nX_b$  consists of co-ordinated polyhedra having *N* corners, each corner is shared by  $Nb/a$  polyhedra. The sharing is usually of corners only, sometimes of edges, and less often of faces.

#### CHEMICAL ABSTRACTS.

**Structure Investigation of Silver Permanganate.** Wilhelm Büsser and Karl Herrmann. *Ztschr. f. Krist.*, 1930, LXXIV, 458.

Both crystallographic and X-ray measurements were made on  $AgMnO_4$ . The crystals are monoclinic, the space group being  $C_{2h}^5$ . The unit cell contains 4 molecules and  $a = 5.66$ ,  $b = 8.27$ , and  $c = 7.12$  Å.U. The structure can be considered as a slightly deformed  $KMnO_4$  lattice. A density determination gave 4.49.

#### CHEMICAL ABSTRACTS.

**The Structure of Silicates.** W. L. Bragg. *Ztschr. f. Krist.*, 1930, LXXIV, 237 (in English). (Cf. *Chem. Abs.*, XXIII, 5371.)

This is a summary of the present knowledge of silicate structures. Individual minerals and isomorphous groups are described and discussed. The various structures are classified as: (1) orthosilicates, with independent  $SiO_4$  groups; (2) complex Si-O groups, such as  $Si_2O_7$  or  $Si_6O_{18}$ ; (3) Si-O chains, as found in pyroxenes and amphiboles; (4) Si-O sheets, which are probably characteristic of mica-like minerals; (5) 3-dimensional Si-O networks. These groups show a progressive reduction in the Si-O ratio. There is a discussion of interatomic distances, isomorphous replacements, co-ordination numbers, and Pauling's rule of compensation as applied to silicates. Complete bibliography.

#### CHEMICAL ABSTRACTS.

**Atomic Analysis by X-ray Spectroscopy.** T. H. Laby. *Trans. Faraday Soc.*, 1930, XXVI, 497.

The X-ray method of detecting the atomic constituents of a substance is compared with other methods, *viz.*: (1) chemical, (2) optical spectroscopic, and (3) positive-ray methods. Spectroscopic methods are in general to be preferred to chemical ones when only very small quantities of the sample are available, or when the unknown substance is present in only very minute traces. The X-ray method has the following advantages over the optical: simplicity and relatively short range of the X-ray spectrum due to a given atom; certainty of identification of lines of



elements according to Moseley's law; the fact that, for elements of nearly the same atomic number, the intensities of corresponding emission lines, excited with equivalent excitation potentials, are in the same ratio as that of the respective numbers of atoms of the elements in the mixture. The last consideration makes possible the use of the X-ray method for other than very small concentrations, a condition necessary for the quantitative interpretation of results obtained by the optical method. The X-ray method is probably more sensitive than the optical, although sensitiveness depends to a great extent upon the elements investigated and experimental technic. Elements have been detected in concentrations as small as 1 part in  $10^3$ . The experimental methods of X-ray analysis are briefly discussed, and a short description and an illustration of the apparatus are included. The importance of a satisfactory experimental technic is stressed.

#### CHEMICAL ABSTRACTS.

Separation of Carbon from Carbon Monoxide in Iron. III.—The Formation of Iron Oxides and Iron Carbides in the Solid Phase. Ulrich Hofmann and Edeltraud Groll. *Ztschr. f. anorg. u. allgem. Chem.*, 1930, CXCI, 414.

O-free CO was passed over pure Fe, prepared from  $\text{Fe}(\text{CO})_5$ . The solid phase was examined with X-rays by the method of Debye-Scherrer. Up to  $450^\circ$ , graphite and  $\text{Fe}_3\text{C}$  were found with little Fe and  $\text{Fe}_3\text{C}$ ; from  $450^\circ$  to  $650^\circ$ , graphite and FeO and small quantities of  $\text{Fe}_3\text{C}$ ; from  $450^\circ$  to  $650^\circ$ , graphite and FeO and small quantities of  $\text{Fe}_3\text{C}$ , Fe and  $\text{Fe}_3\text{O}_4$ ; above  $655^\circ$ , Fe, C and  $\text{Fe}_3\text{C}$  but no FeO or  $\text{Fe}_3\text{O}_4$ . At  $320^\circ$  and  $275^\circ$ , CO was passed over pure  $\text{Fe}_2\text{O}_3$ . X-ray examination showed  $\text{Fe}_3\text{O}_4$  and  $\text{Fe}_3\text{C}$  in the solid phase. Unknown lines were attributed to a C-rich carbide,  $\text{Fe}_2\text{C}$ , which is unstable at higher temperatures. Benzine vapors passed over Fe at  $700^\circ$  together with O-free  $\text{N}_2$  gave C, Fe and cementite in the solid phase. The results are discussed with reference to the phase diagram of Schenck (*Chem. Abs.*, XXII, 2132). Attempts to detect oxoaus-

ite in the solid phase were unsuccessful. According to Schenck (*Chem. Abs.*, XXII, 936), this occurs in carbonization above  $575^\circ$ . The CO-CO<sub>2</sub> analyses obtained at  $700^\circ$  are within this field but only cementite and  $\alpha$ -Fe were found in the solid phase. The latter was cooled both in  $\text{H}_2\text{O}$  and in liquid  $\text{N}_2$  but since the mass is in the form of a fine powder because of the separation of C cooling may not be rapid enough to prevent decomposition of oxoausenite.

#### CHEMICAL ABSTRACTS.

### CHEST (DIAGNOSIS)

Neurofibroma Arising on the Pericardial Pleura. William L. Keller and George R. Callender. *Ann. Surg.*, October, 1930, XCII, 666.

A Filipino house servant, a woman of 38 years, complained of pain and tenderness in various joints, stiffness of one knee joint, and swelling and clubbing of the fingers. Roentgenographic examination of the thorax showed a tumor in the left lower chest which moved with the diaphragm. A phrenicotomy was performed and thirteen days later the tumor was removed. The tumor was encapsulated, with numerous vessels in its smooth capsule, and attached to the pericardium by a broad pedicle, 5 cm. in diameter, and to the lower lobe of the left lung by a smaller pedicle 2 cm. in diameter, over the course of the left phrenic nerve. It was irregularly oval in shape, weighed 660 grams, and measured 14 by 11 by 8 centimeters.

Following the operation the osteo-arthropathy demonstrated some improvement. Reproductions of X-ray films of the chest before operation and one and one-half years later, showing no recurrence, are included.

F. B. MANDEVILLE, M.D.

Deformation and Displacements of the Hilum in Pulmonary Sclerosis and Pleural Adhesions. Guido Pescatori. *La Radiologia Medica*, May, 1930, XVII, 509.

This is a complete and comprehensive study of pulmonary kinematics. The author discusses the interpretation to be given, with dif-

ferent radiographic images of the chest, and illustrates his article with abundant radiographic material. Special emphasis is laid upon the movement of the hilum and its position, since it is considered by the author as the most eloquent factor in the diagnosis of pleural or pulmonary sclerosis.

The article is so detailed that it is impossible to give a complete abstract of it in restricted space.

L. MARINELLI.

**Syphilis of the Lungs.** Karl Herman. *Röntgenpraxis*, Oct. 15, 1930, II, 916.

Syphilis of the lungs is a very rare disease and can easily be mistaken for tuberculosis, carcinoma, or chronic pneumonia. Clinically, syphilis of the lungs may present itself in three types: (1) Syphilitic bronchitis; (2) chronic pneumonia; (3) chronic pseudophthisis. The roentgen appearance alone is not diagnostic. The Wassermann reaction and the result of specific therapy assist one in making a definite diagnosis. Two cases are described in detail in which the roentgenologic and clinical examinations and the success of anti-syphilitic treatment made the diagnosis of lung syphilis certain.

H. W. HEFKE, M.D.

**Further Studies on Cardiac Pulsation in Pneumothorax.** Alessandro Vallebona. *Archivio di Radiologia*, July-October, 1930, VI, 827.

In this study the author shows that jerky pulsation of the heart is most marked at the end of expiration, and is due to changes in pressure in the pleural cavity and altered relationship between the lungs and heart.

E. T. LEDDY, M.D.

**A System of Reading X-ray Films for Use in Sanatoria.** Duncan McRae. *Am. Rev. Tuberc.*, June, 1930, XXI, 811.

The system described by the author is the one used in the Manitoba Sanatorium, and he claims it has proven very satisfactory. This, in the main, consists of the use of certain letters, figures, and abbreviations to indicate the

presence or absence of certain conditions and their extent: thus "*RD up 2, tied*," we judge, means that the right diaphragm is elevated above the normal, and fixed. A system of this kind in an institution with a constant staff may work out satisfactorily, but a report of this nature would hardly be satisfactory if sent out to a physician not familiar with the language.

In an X-ray laboratory doing general work for varying groups of physicians, it would hardly prove practical. The fact, however, that it encourages detailed study and systematic reading recommends it.

S. C. BARROW, M.D.

**Bronchography—the Passive Technic.** F. H. Cooley. *Journal-Lancet*, Aug. 1, 1930, L, 373.

(*Abstractor's note*.—It is the custom in many places for the physicians to refer patients to radiologists for the introduction of opaque oils into the bronchi preparatory to X-ray examination. Any simplification of the technic will be welcome to radiologists, therefore.)

The use of the passive technic is based on the physiology of swallowing, which is partly voluntary and partly involuntary, the latter dependent upon the former. Sensory anesthesia of the anterior pillars of the fauces will abolish the reflex act, preventing elevation of the larynx and, therefore, opening of the esophageal orifice. Any substance entering the pharynx under such conditions must pass down the larynx.

After cleansing the mouth, the anterior surface of the anterior tonsillar pillars is swabbed with a 10 per cent solution of cocaine until the swallowing reflex is abolished, usually three or four swabbings. Then three or four c.c. of a 3 per cent cocaine solution is given the patient, who is told to lean back, protrude the tongue, lean toward the side to be filled, and breathe naturally. The solution will be aspirated into the lung. Then the faucial pillars are again swabbed, and the patient is given 10 c.c. of iodized oil, which is aspirated into the lung in the same manner as the cocaine solution. After expectoration of sali-

va, another 10 c.c. is introduced. This is an ideal procedure for bronchography.

W. W. WATKINS, M.D.

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**The Hairline in the Roentgenogram of the Lungs.** L. Schall and F. Hoffmann. *Röntgenpraxis*, Nov. 1, 1930, II, 977.

In good roentgenograms of the lungs, one may occasionally see a very fine line in the right mid-chest, either straight or slightly curved, which is the so-called "hairline." Hotz found this in 6.5 per cent of his cases, Schönfeld in 13.5 per cent, and the authors in 16.1 per cent in 4,508 films. The authors are of the opinion that this fine line represents the interlobar pleura, the presence of which does not necessarily mean an old or recent interlobar pleurisy. It is probable that the normal interlobar pleura may also cast this shadow in certain cases.

H. W. HEFKE, M.D.

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**Roentgenology of the Upper Respiratory Tract.** Henry K. Pancoast. *Jour. Am. Med. Assn.*, Nov. 1, 1930, XCV, 1318.

The upper respiratory tract from the nasopharynx to the carina has recently become a very important field for roentgenologic diagnosis. The most important factor in diagnosis is a careful study of the soft structures during an examination of the neck. This includes fluoroscopic observations of the movements or changes in lumen of the various portions of the tract during respiration, speech, and swallowing, and the making of roentgenograms for records. In all instances the chest should be included, and especially in infants and young children.

Since the beginning of Hay's work the members of the author's staff have realized that the only way of determining accurately the potential dangers of the thymus in infancy is through a study of its effects on the upper respiratory tract and not by an estimation of its dimensions. The technic of examination is explained and discussed.

The author states that practically all of the pathologic conditions presented by the larynx and neuromuscular disturbances show some

recognizable phenomena or abnormal appearances, many of which are characteristic.

The study of phonation and the swallowing act is essential in all cases. Both of these functions are described in his essay.

CHARLES G. SUTHERLAND, M.D.

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**The Clinical and Roentgenologic Value of the Lateral Chest.** C. H. Warfield. *Illinois Med. Jour.*, December, 1930, LVIII, 461.

The lateral chest is not used as much as it should be, because of the difficulty in securing uniformly satisfactory results. The technic used is 118 P.K.V., 50 ma., one-half second, at a distance of 7 feet, for the average adult of 150 pounds. The patient stands with the affected side toward the film, crossing the arms in front of him, and, grasping them just above the elbows, places them on the flexed head and neck. Holding tight to the head, he raises his arms and head simultaneously until his body is in the vertical position. This position places the shoulders and scapula posteriorly. As deep a breath as possible is necessary to lessen the exposure. It is very important that the tube be placed seven feet or more from the film since the aorta, for instance, is about five inches from the film.

The author discusses the value of this position in cases of foreign body, abscess, aneurysm, aortitis, aortic arteriosclerosis, and the differential diagnosis of pericardial effusion and acute dilatation of the heart, and believes this to be of great value in pathology of the base of either lung. The enlarged thymus should always be studied in the lateral position for evidence of compression and displacement of the trachea.

C. H. DEWITT, M.D.

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**Subacute and Chronic Pulmonary Infections Commonly Mistaken for Pulmonary Tuberculosis.** Hugh J. Morgan, *Am. Rev. Tuberc.*, November, 1930, XXII, 491.

The writer confines his discussion to three diseases commonly met with, *viz.*: chronic bronchitis, subacute or chronic bronchopneumonia, and bronchiectasis. He states that records from Trudeau Sanatorium (1916-1923)

show that 75 per cent of the cases applying for treatment, found to be non-tuberculous, were cases of chronic bronchitis and chronic bronchopneumonia. No clean-cut differential points are given in the discussion of diagnosis from history and physical signs. Under chronic bronchopneumonia, he says the X-ray findings are points of great diagnostic importance, and under bronchiectasis, that X-ray examinations are diagnostic in the majority of cases.

The great value of the article lies in the signal which it sounds for care and the avoidance of hastily pronouncing the non-tuberculous, tuberculous.

S. C. BARROW, M.D.

**Fibrin Bodies in Artificial Pneumothorax Cavities or Pleural Mouse.** H. V. Morlock and Franklin G. Wood. *British Jour. Radiol.*, November, 1930, III, 515.

Three cases of fibrin bodies observed in the pleural cavity, following artificial pneumothorax, are reported in some detail. In two of the cases an effusion preceded the appearance of the fibrin body, and in the third an effusion may have previously existed, although this was not definitely proven. The authors believe the theory of formation of fibrin bodies around a nidus of a fibrin flake or particle to be more probable than from the deposition of blood fibrin, following a traumatic hemorrhage of an intercostal artery. One case had been studied over a period of four years and the only change noted was a slight reduction in the size of the body. In most instances, change in position of the fibrin body could be demonstrated, hence the name "pleural mouse."

J. E. HABBE, M.D.

**Bronchiectasis: An Analysis of 51 Cases.** W. W. Priddle. *New York St. Jour. Med.*, Sept. 15, 1930, XXX, 1077.

Bronchiectasis was diagnosed in 7.1 per cent of all cases in the adult medical wards of the Buffalo City Hospital. Lemon has found that 4 per cent of all children admitted to the Mayo Clinic have bronchiectasis. In the group re-

ported upon, incidence is greatest between 40 and 60 years of age, the onset occurring before the age of 20 in 21.5 per cent. Males were affected 4.1 times as frequently as females. Pulmonary infection in childhood is connected with bronchiectasis in a large percentage of cases. There was wide variation in the type of lesion found in the bronchus and surrounding lung parenchyma. Lesions were usually basal and more frequently on the left.

Roentgenography, as in any chest condition, was a real aid, but only in conjunction with clinical findings. In this series the X-ray department made a positive diagnosis in 64 per cent of the cases from plain films. The absolute diagnosis can be made only by the use of iodized oil injections, which give an accurate picture of the nature and extent of the lesion. This procedure should be used, however, only after other methods have been carefully considered. In 47 cases out of 51, clinical diagnosis was made by the history and physical findings alone.

W. W. WATKINS, M.D.

**Localized Pneumothoraces as a Cause of Annular Shadows in Roentgenograms of the Chest.** W. P. Warner. *Am. Rev. Tuberc.*, November, 1930, XXII, 531.

This article is a complete clinical history, with X-ray findings and postmortem study, of a patient whose chest showed two large annular shadows, diagnosed by the radiologist as localized pneumothoraces, and so proven at postmortem. The author states that this is the only case found in the literature in which annular shadows resembling cavities, diagnosed as localized pneumothoraces, have been proven at autopsy. A very thorough review of the opinions, theories, and findings of the many who have written on the subject is given, making a valuable reference table for those interested in the question, "What are annular shadows?" The study of this case unfortunately does not determine the content of these cavities, or disprove a positive air connection with the lung, owing to accompanying pathology.

The report is a valuable one and should be studied carefully, along with the references,

by all roentgenologists engaged in chest examinations.

S. C. BARROW, M.D.

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**The Normal and Pathologic Interlobar Fissure in the Roentgenogram.** I. G. Brdiczka and G. Wolf. *Röntgenpraxis*, Nov. 15, 1930, II, 1014.

The normal interlobar pleura may be demonstrated on an X-ray film. It presents itself as a very thin hair-line caused, in most cases, by the folding of pleura over the edge of the lung rather than by the projection of the interlobar pleura itself. The fine line is found in about 40 per cent of normal cases. Moderate thickening of the line indicates an old pleuritic process while a markedly thickened line proves the presence of interlobar adhesions.

H. W. HEFKE, M.D.

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**"Pleural Rings" or Annular Shadows in the Lungs.** William Mitchell. *British Jour. Radiol.*, October, 1930, III, 446.

The author at once excludes ordinary tuberculous cavities and discusses those remaining annular shadows so puzzling to most radiologists. He prefers the term "air cysts," and believes that they almost always represent air spaces within the lung, produced by perforation of a small bronchus, with escape of air into the connective tissues in the form of a single bubble of air. If there is a ball-valve action between the bronchus and the air space, allowing ingress only of air into the "air cyst," then there may be a rapid increase in the size of the annular shadow. If, on the other hand, the point of perforation is healed over, then the imprisoned air may be quickly absorbed, with rapid decrease in size of the shadow. The author believes these air cyst shadows to be pathognomonic of tuberculosis, even in the absence of pulmonary fibrosis.

J. E. HABBE, M.D.

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**X-ray Diagnosis.** Kenneth D. A. Allen. *Colorado Med.*, November, 1930, XXVII, 424.

This short paper is part of a symposium on atelectasis, and describes the diagnostic rôle

played by the X-ray in post-operative chest complications, with special reference to atelectasis. The X-ray plays its part in the following: (1) determining the behavior of the diaphragm, by films taken in expiration or inspiration,—or by fluoroscopy; (2) by determining the X-ray signs of atelectasis, and the type of lesion. The X-ray signs of atelectasis are (a) the displacement of the heart, mediastinum, and sometimes the tracheal shadows toward the affected side; (b) high diaphragm on the affected side; (c) decreased radiolucence of the atelectatic area; (d) increased radiolucence on the opposite side; (e) narrowing of the rib spaces; (f) affected lung curves toward the spine, while the opposite lung curves away from the spine; (g) heart moves toward the affected side in inspiration; (h) restriction of the diaphragm on the affected side. Atelectasis may be massive or localized. The localized type is not as clear-cut and requires close co-operation between the members of a medical team to make an accurate diagnosis.

W. W. WATKINS, M.D.

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**Our Growing Dependence on the X-ray.** Editorial. *Canadian Med. Assn. Jour.*, October, 1930, XXIII, 563.

This editorial sums up rather well the changing attitude of the profession in general toward the radiologist. Quoting a speaker at the British Medical Society meeting in Australia, who, in discussing the value of radiology in the diagnosis of diseases of the chest, referred to the "physician with a guarded admiration for the radiologist, and the radiologist with no admiration for the physician," the Editor indicates that, while this is not the average viewpoint, it does reflect to some extent the stages through which medical opinion has passed or is passing, with regard to the place of the X-ray in the diagnosis of chest disease.

The Editor quotes from such "guarded admirers" of the radiologist as Cabot in his "Physical Diagnosis," and Morriston Davies and Sir Thomas Horder. Cabot is quoted as follows, "In incipient tuberculosis the X-ray as often leads us wrong, as right." Davies

says, "Radiology has helped to confuse us"; while Horder refers to the "bastard pathology" of the radiologist.

But the radiologist has his turn. Dr. Gerald Webb says, "Roentgen examination is the only method available for detecting early pulmonary tuberculosis." Dr. L. H. Fales is quoted: "The roentgen ray is the most important means of determining the existing pathological condition of the lungs."

With this latter viewpoint the Editor is in accord when he writes, "Where is the hospital which cannot show radiographs of pulmonary cavities whose presence had at best been only hinted at in the physical examination, but not diagnosed; or of foreign objects in the lung whose manifestations had for years been translated as those of tuberculosis?"

The Editor sums up the proper relation between the radiologist and the clinician as one of "co-operation." Each is supreme in his field, and the work of each should be the complement of that of the other, with resulting fixation of diagnosis. While the X-ray often provides information with an accuracy to which the physical examination cannot attain, it must not be depended on as a short-cut. It is an added source of information, which may confirm, correct, or amplify a diagnosis, or may fail to do any of these things.

L. J. CARTER, M.D.

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Early X-ray—Early Diagnosis. William B. Davidson. *New England Jour. Med.*, Oct. 30, 1930, CCLIII, 860.

Without early X-ray, the diagnosis of an early lesion of tuberculosis cannot be made. Especially is the early X-ray examination important in the childhood type of tuberculosis, not forgetting that the adult can have the childhood type. In a differential diagnosis the X-ray examination is indispensable. The author's technic, which is not essentially different from the usual technic, is described. He sees no advantage in extra-rapid exposure. Stereoscopic films have not been found to be more valuable than flat films, although the oblique or lateral views of the chest are recommended. Fluoroscopic examination should

be used as an adjunct. The classification of McPhedran is followed in the childhood type.

(*Abstractor's note:* It is refreshing to find a writer who is not afraid to say that the flat film is usually as useful as the stereoscopic film. It is believed that many radiologists have this view, and practise it, though the common expression, "excellent stereoscopic chest films are essential," bluffs them.)

W. W. WATKINS, M.D.

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Diagnosis and Treatment of Non-tuberculous Suppurative Lung Lesions. James H. Stygall. *Jour. Indiana St. Med. Assn.*, November, 1930, XXIII, 526.

Our conception of lung suppurations has changed considerably in the last fifteen or twenty years, principally because of the use of the X-ray, lipiodol, and the bronchoscope. There are three common types of lung supuration—and they may be co-existent—namely, bronchiectasis, empyema with bronchial fistula, and lung abscess. Bronchiectasis is frequently undiagnosed, and unaided X-ray examination may be of little value, but by outlining the bronchial tree with lipiodol, the diagnosis is quickly made by the use of the X-ray film or under the fluoroscope. In lung abscess the physical signs are often negligible and at best depend on the proximity of the abscess to the periphery. The physical examination cannot be depended on entirely and should always be supplemented by the X-ray.

W. W. WATKINS, M.D.

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The Limitations of the Roentgenologic Diagnosis of Diseases of the Thorax. Ernst Lachmann. *Röntgenpraxis*, Sept. 1, 1930, II, 769.

This article endeavors to show how seldom the roentgenologic symptoms of a chest disease are absolutely pathognomonic, and in which cases the anatomical changes are not demonstrable by means of the roentgen ray. The author's own experience and the opinion of other authors quoted from the literature make a very instructive essay on the limitations of the roentgenologic chest diagnosis. Although the roentgen examination is prob-

ably the most valuable means of diagnosis to the clinician, it should be closely associated with other diagnostic methods.

H. W. HEFKE, M.D.

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**Silicosis.** T. H. Belt. *Canadian Med. Assn. Jour.*, December, 1930, XXIII, 802.

Silicosis is a purely industrial disease, affecting the lungs of persons whose occupations expose them over long periods to the dust of hard rock. The disease has received a great deal of attention in Africa, where, for many years, it has been a serious problem in the mining industries. Only within the past six years has the disease received serious attention in Canada, but in the Province of Ontario it is now recognized as a compensable form of disability.

Silicosis is characterized by extreme chronicity. It runs entirely to fibrosis of the lungs, and, while not fatal in itself, renders the victim particularly vulnerable to pulmonary infections. The majority of sufferers from silicosis eventually develop tuberculosis of the lungs, and the combination almost invariably proves fatal. In the presence of silica, the tuberculous infection runs wild, but the reason for this is unknown. Numerous theories of an explanatory nature are enumerated by the author.

L. J. CARTER, M.D.

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**Mediastinal Pleural Effusion: A Roentgenologic Study.** Jacob Sagel and Leo G. Rigler. *Am. Jour. Roentgenol. and Rad. Ther.*, September, 1930, XXIV, 225.

The author states that mediastinal effusion is not so infrequent as formerly believed, and is often overlooked clinically, due to difficulty in diagnosis. It is generally encapsulated but may rarely occur as a free pleural effusion and extend secondarily into the lateral pleural cavity. Anatomically, the mediastinal pleural cavity is divided into two parts, an anterior and a posterior, which are separated by the pulmonary ligament. Considering location there are four possible kinds of mediastinal pleural effusion: (1) that in the anterior space on one side; (2) that in the posterior

space on one side; (3) the bilateral type, and (4) the so-called "saddle type." Etiologically there are two chief types: (1) the serous type, which is generally associated with pulmonary tuberculosis, and (2) the purulent type, which is usually pneumococcic or, rarely, streptococcic in origin. The purulent type generally follows pneumonia and should be sought for when prompt return to normal does not occur, after the usual period of illness.

As to the technic of examination, both roentgenoscopic and roentgenographic methods are used. The characteristic roentgen finding is a triangular shadow on either side of, and continuous with, the median shadow, from which it cannot be separated regardless of the position in which the patient is placed. It may displace the adjacent part of the lung or heart, usually the latter, to the opposite side. No cardiac pulsation is visible in this abnormal shadow. In some cases of posterior mediastinal involvement typical symptoms are produced, due to pressure on structures in the mediastinum. In the series of 15 cases cited, the posterior type predominated, recovery occurring in all but one case. Six were empyemas in the posterior space and were proved by thoracentesis. The article is well illustrated.

J. E. HABBE, M.D.

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## CHEST (GENERAL)

**Bronchomycosis: Report of Two Cases.** William Royal Stokes, Edgar F. Kiser, and William H. Smith. *Jour. Am. Med. Assn.*, July 5, 1930, XCV, 14.

The etiologic relationship of certain forms of budding fungi included under the general name of *Endomyces* has been described by Castellani in calling attention to chronic bronchial infections in which tubercle bacilli in the sputum were never demonstrated. Such sputum, however, constantly contained various yeast-like organisms, which he divided into several groups.

Two cases are reported in which extensive chronic interstitial fibrosis existed and tubercle bacilli were not demonstrated in the sputum. A form of yeast was obtained in both,

which in morphology and cultural characteristics resembled *Monilia albicans* as given in Castellani's table, with one exception. This organism, injected into white rats, produced a pathologic condition similar to that produced by the tubercle bacillus, but these lesions did not show any tendency to spread through the internal viscera, and remained either as local processes or as scattered nodules on the serous surfaces.

Other observations showed this single exception to Castellani's grouping, and seemed to classify the organism as *Monilia albicans*. The isolation of these fungi from the sputum is, of course, no proof that they have produced the clinical conditions described. The repeated absence of tubercle bacilli and of other organisms suggests an etiologic relationship.

CHARLES G. SUTHERLAND, M.D.

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**Post-operative Pulmonary Hypoventilation.** Richard H. Overholt. Jour. Am. Med. Assn., Nov. 15, 1930, XCV, 1484.

Variations from the normal and physiologic conditions below the diaphragm, which occur after laparotomy and their effect on the position and activity of the diaphragm, indicate that pulmonary hypoventilation exists for a variable time after operation. A routine study of the chests of patients before and after upper abdominal operations showed a 75 per cent diminution of chest expansion after operation. The thoracic circumference became greater after operation. The observations indicated that free, normal respiratory activity is interfered with after the abdomen has been opened. Roentgenograms showed the superior-inferior diameter of the thorax to be greatly diminished in the post-operative films because of a marked elevation of the diaphragm. Fluoroscopic observation showed a 33 to 50 per cent reduction in diaphragmatic excursion after operation. Anything approaching physiologic aeration of a greater portion of the lower lobes during inspiration is impossible because of the position of the diaphragm and its diminished excursion. There would seem to be a definite mechanical disturbance to respiration as a consequence of

the admission of air into the peritoneal cavity. A study of the vital capacity of 218 patients was made before and after the performance of abdominal operations. Following operations on the upper abdomen, the vital capacity was reduced 64 per cent of the pre-operative or normal value. Following lower abdominal operations the average vital capacity was reduced 40 per cent of the normal value. Approximately a 15 per cent reduction in the vital capacity could be attributed to a tightly fitting abdominal binder applied post-operatively. When an ordinary surgical dressing of gauze and adhesive tape was applied, very little change in the vital capacity was noted.

The effect of pain in limiting respiration after operation was investigated by studying patients still under the influence of spinal anesthesia. From this study it would seem probable that a mechanical interference with respiration occurs at the time the abdomen is opened. This is confirmed by the experimental evidence. That pain is also an important factor cannot be denied. In cases in which symptoms of hypoventilation are very evident, treatments with carbon dioxide are given at regular intervals for a period of three or four days, post-operatively. Frequent turning and deep-breathing exercises should be resorted to early in every case.

The author suggests a post-operative procedure of having the anesthetist give carbon dioxide inhalations under positive pressure, as the abdomen is closed. Air in the abdominal cavity is displaced by a physiological solution of sodium chloride, which is removed by suction as the peritoneum is finally closed. A tightly fitting, many-tailed binder should not be used when there is pulmonary embarrassment. The free post-operative use of morphine should be encouraged.

C. G. SUTHERLAND, M.D.

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**Dust and Pulmonary Disease.** Albert E. Russell. Jour. Am. Med. Assn., Dec. 6, 1930, XCV, 1714.

The advances which have been made in all branches of industrial medicine have helped to center attention on dust and its effect on the health, as the number of the workers in dusty



plication. It may be of any extent, from involvement of very small portions of pulmonary parenchyma to a whole lung or both lungs. After reviewing a mass of literature of the past hundred years, including the papers by Coryllos and Birnbaum, Bowen, Van Allen and many others, the authors conclude that bronchial obstruction is the most important single factor in the production of atelectasis, and that with the relief of the obstruction the lung re-inflates. The pre-operative, operative, and post-operative factors, which may aid in the formation of this lesion, are discussed in detail.

Bronchoscopically, four types of findings in atelectasis were noted: (1) the presence of an obstructing plug or characteristic tenacious sputum; (2) a profuse purulent secretion; (3) no secretion in the bronchi; (4) one unusual case of local bronchial edema. The use of bronchoscopic aspiration in prophylaxis as well as in treatment was suggested, and the importance of applying the principles of intra-bronchial drainage in the posture of the patient, in combination with CO<sub>2</sub> inhalations, was discussed.

The uncomplicated post-operative lesion presents an excellent prognosis. All post-operative pulmonary complications, excluding embolic types, are not believed to be of the same nature. From clinical, X-ray, and bronchoscopic observations, the authors believe that there seems to be one type more like lobar pneumonia, and they discuss a case illustrated with roentgenograms. A large and most excellent bibliography is attached.

F. B. MANDEVILLE, M.D.

### CONTRAST MEDIA

**A New Method of Blood Vessel Visualization (Arteriography, Veinography, Angiography) *in Vivo*.** Makoto Saito, Kazunori Kamikawa, and H. Yanagizawa. *Am. Jour. Surg.*, November, 1930, X, 225.

The authors review the work that has been done in this line up to the present time, and describe their solution as a fine emulsion of iodized oil, originated by Professor Hattori

of the Tokio Imperial University. To prepare it protalbinacid was used. The preparation is a yellowish-white, slightly alkaline, isotonic emulsion. No hemolytic or rapid hemostatic action *in vivo* or *in vitro* was found. Each oil globule is smaller than a blood corpuscle.

This new contrast medium, called L'ombre, has given clear, satisfactory roentgenographic films. It has also been used in pyelography, myelography, and visualization of fistulæ and articular cavities. For pyelography it is especially valuable because of the low viscosity, the absence of irritation to the mucous membranes, and the strong radio-activity which insures very clear shadows.

The original article should be consulted for the technic in using this solution and for its preparation.

HOWARD P. DOUB, M.D.

**Roentgen Diagnosis of Synovial Adhesions.** Editorial. *Jour. Am. Med. Assn.*, Dec. 6, 1930, XCV, 1749.

Following fifteen years of patient experimentation, another unusual chemical adjunct to roentgen diagnosis seems to be available. With this new aid, altered permeability of synovial membranes can be determined, and accurate pictures secured of synovial adhesions. Demonstrations of abnormal synovial permeabilities were made about sixteen years ago by Dr. Henry Keller, orthopedic surgeon of the Neurological Hospital, New York, who injected easily diffusible dyes into joint cavities, and followed their subsequent excretion by the kidneys. Disodium salt of tetraiodo-orthosulphobenzoic acid is a non-toxic chemical substance readily excreted by the kidney, and of sufficient density to cast a distinct shadow on the X-ray film. This sodium salt is odorless, tasteless, and readily soluble in water, an 11.3 per cent solution being isotonic with human blood. The isotonic solution is non-irritating when instilled into the conjunctival sac of the human eye. Injection into laboratory animals does not cause local irritation. Intravenous injections are well borne by animals and the injected drug is rapidly excreted by the kidneys. Kidney function is

not impaired. With ordinary concentrations, no depression is demonstrable with isolated smooth muscles. Albino rats, previously trained in a circular maze, do not show impairment of memory on administration of the new drug or alteration in neuromuscular control. Injected into joint cavities of dogs, the new compound gives sharply defined X-ray shadows of joint cavities.

C. G. SUTHERLAND, M.D.

**Uroselectan in the Demonstration of Blood Vessels (Vasography) and Especially of Varicosities.** Max Ratschow. *Fortschr. a. d. Geb. d. Röntgenstr.*, July, 1930, XLII, 37.

For successful roentgenologic demonstration of the blood vessels, four demands have to be met by the contrast medium to be employed: It must not harm the interna of the vessels, nor produce disturbance of circulation or affection of the organism, but it should be sufficiently radiopaque in high dilution. All opaque oils produce fatty embolism and bronchopneumonia. Strontium bromate produces thrombosis of vessels.

Uroselectan proved to be a very satisfactory contrast medium, and, as demonstrated in a series of reproductions, permitted of excellent visualization of veins and especially of varicosities.

HANS A. JARRE, M.D.

**Uterosalphingography in General Practice: with Case Reports.** J. Martin Johnson. *Wisconsin Med. Jour.*, September, 1930, XXIX, 497.

The author's procedure is preliminary and operative. In the preliminary stage, a careful history is taken and complete physical examination made; this latter includes determination of the patency of the cervix, and dilatation of the canal is made. Following this, the patient may be taken or sent to the X-ray laboratory, the co-operation of an experienced roentgenologist being deemed essential. With the patient on a table equipped with a Bucky diaphragm, by means of the Pressometer, lipiodol is injected. The fluoroscope may be used to follow the injection, if desired.

After four or five c.c. have been injected, the first film is made and the patient is allowed to flex or extend her legs, though without disturbing the nozzle in the uterus. After developing the first film and noting the amount of oil injected, a second injection is made. A total of 10 c.c. should be sufficient in the majority of cases. This procedure definitely outlines the uterus and tubes, and localizes the point of obstruction if the tubes are not patent. The procedure is harmless and may be readily accomplished by the physician who adheres to fundamental principles.

W. W. WATKINS, M.D.

### DIAPHRAGMATIC HERNIA (DIAGNOSIS)

**Progress in the Roentgenologic Diagnosis of Diaphragmatic Hernia.** Alexander B. Moore and B. R. Kirklin. *Jour. Am. Med. Assn.*, Dec. 27, 1930, XCV, 1966.

A vast and growing literature on diaphragmatic hernia attests the keen interest in this condition. From experience it is evident that diaphragmatic hernia is not merely a pathologic oddity, but a lesion which should be taken into practical account and given higher rank among the possibilities to be canvassed at examination. Recent publications emphasize the congenital factor, whereas in earlier days the acquired form, principally that resulting from violent crushing injury, was stressed. An increase of intra-abdominal pressure is often doubtless the cause of hernia, congenital gaping of the hiatus esophageus or other foramina, or developmental weaknesses in other portions of the diaphragm, usually being a significant predisposing element. An interesting variety is that in which the esophagus is congenitally shortened. When the entire stomach lies above a normally developed diaphragm, some prefer the designation "thoracic stomach," and classify it apart from the hernias.

Case reports, over the last five years, deal with traumatic hernias through breaches in various parts of the diaphragm, parasternal and other hernias, congenital or acquired, all differing in details but fundamentally alike in their diagnostic problems. The aggregate of

new reports tends to confirm the accepted fact that the stomach is most frequently implicated in the hernia and is followed by the colon, small bowel, omentum, spleen, pancreas, and liver, singly or in varying combinations. Of all the cases now on record, the vast majority were revealed by the roentgen ray. Obviously, then, the roentgenologist has a virtually clear field and a proportionate responsibility for this diagnosis. The chief obstacle to the diagnosis of diaphragmatic hernia is the neglect to look for it. The examiner is often obliged not only to consider all details with extraordinary care, but also to resort to special technics. Unless the hernia is extremely small or is reduced spontaneously at the moment, thoracic changes will be evident in the chest roentgenogram. Any deviation in the terminal course of the esophagus or retarded entrance of the barium into the stomach, should at least suggest the thought of hernia. Distortion of the stomach in hernia of any type is variable in degree and configuration. Rarely, as in a congenital absence of the left diaphragmatic arch or in a gross traumatic hernia, little distortion occurs. Most often, however, the stomach is only partially herniated and hour-glass deformity results rather constantly. Since the fundamental distinguishing mark of hernia is the supradiaphragmatic situation of abdominal organs it is necessary, although sometimes difficult, to trace the outline of the arches. Often the arch is irregular, or sinuous, or angulated at the point of rupture, or the margins of the breach may form a visible collar. Respiratory movements of the arch may be normal, diminished, absent, or reversed, depending on the size of the hernia and the extent of fixation by adhesions. Completing the picture are displacement of the heart, if the hernia is large, and shading of the lung, in proportion to the amount of compression.

Ordinary technic is often inadequate and must be supplemented by special methods. The advantages of the lateral view have been dwelt upon. The prone position, with manual pressure on the abdomen, has revealed hernias not demonstrable otherwise. Deep inspiration by the patient, or bending over, while in the standing position, or strong manual pres-

sure over the abdomen may cause re-appearance of a spontaneously reduced hernia. Examination of the stomach for diaphragmatic hernia is not decisive unless both the erect and recumbent postures are employed, and careful search, by the special methods outlined, is made. Diaphragmatic hernia cannot be absolutely excluded without an examination of the colon with the barium enema. Serial observations of the ingested opaque meal may be advantageous or necessary in establishing the diagnosis of the rare cases in which the small bowel alone is implicated. Cardio-esophageal relaxation, characterized by dilatation of the epicardia and ready reflux of the barium into the esophagus, might be confounded with hernia. Eventration is perhaps the most deceptive simulant of hernia. In eventration, the upper level of the barium in the stomach always coincides with the esophageal opening when the patient is erect, whereas, in hernia, the upper level of the gastric content is likely to be above the plane of the esophageal aperture.

CHARLES G. SUTHERLAND, M.D.

A Very Large Diaphragmatic Hernia. P. Eichler. *Röntgenpraxis*, Aug. 1, 1930, II, 712.

A very large diaphragmatic post-traumatic hernia was found in a patient in whom the stomach and colon almost filled the entire left chest, reaching to the level of the clavicle. The examination of the chest pointed to a seropneumothorax, and only during the examination of the stomach, by means of a barium meal, could the exact diagnosis be made.

H. W. HEFKE, M.D.

## DOSAGE

The Effect of Graded Doses of Roentgen Rays on the Mitosis in *Vicia faba equina*. O. Jüngling and H. Langendorff. *Strahlentherapie*, 1930, XXXVIII, 1.

The authors studied the mitosis in roots of *Vicia faba equina* under normal conditions. The curves, plotted with the number of mitoses as ordinate and the time as abscissa, showed a certain rhythm. Exposure to roent-

gen rays in doses of 40, 50, 175, 420, and 550 r changed the curves materially. Small doses which did not produce macroscopic nor microscopic changes accelerated the course of the mitosis. Large doses producing definite injuries caused the aforementioned change in the slope and shape of the mitotic curves, as compared with the untreated controls. The principal effect consisted of an increase of the time between two mitotic cycles. For details of the changes a study of the curves is recommended.

ERNST A. POHLE, M.D., Ph.D.

**A Contribution to Dosimetry with the Sabouraud-Noiré Tablet.** Karl Hoede. *Strahlentherapie*, 1930, XXXVIII, 173.

The author compared the Sabouraud-Noiré Tablet at potentials of 75 K.V., and 120 K.V., unfiltered, 0.5, 1.0, and 4.0 mm. Al, with a Hammer dosimeter. He found that, in addition to the sources of error demonstrated by previous investigators, there is to be added the absorption by the tablet holder. Depending on the penetration of the radiation, this error may amount to as high as 50 per cent.

ERNST A. POHLE, M.D., Ph.D.

**The Necessity of Exact Dosage Data in Grenz-ray Therapy.** O. Gfrörer and Heinz Berger. *Strahlentherapie*, 1930, XXXVIII, 184.

Emphasis is laid upon the fact that the half value layer is not a good quality factor in Grenz-ray therapy. It is essential to indicate the peak kilovoltage, the tube current, the window-to-skin distance, and the output in r-units.

ERNST A. POHLE, M.D., Ph.D.

**A Biological Calibration of an X-ray Dosimeter.** Charles Packard. *Jour. Cancer Research*, March, 1930, XIV, 134.

The author calibrated a Victoreen dosimeter, 1928 model, by a biological method. The eggs of the *Drosophila* were radiated and the proportion which hatched, following radiation, was determined. It has been found that when these eggs are subjected to a radiation of a

definite number of r-units, a certain percentage hatch. This is independent of the quality or wave length of the X-radiation employed. A curve was obtained showing the percentage of eggs hatching after various doses measured in r-units by a large, open ionization chamber. This curve is not accurate for very small or very large doses. The dosimeter was tested and calibrated against the curve at 60, 100, 150, and 200 kilovolts. The first three were obtained on a Wappler Diex (thermionic rectification). The test with 200 K.V. was made with a mechanically rectified outfit.

The author found that the dosimeter records the dosages correctly, according to this method, when the voltages range from 100 to 200 kilovolts. Under 100 K.V., the full intensity was not registered, being about 13 per cent too low at 60 kilovolts.

JOHN R. CARTY, M.D.

**The Reproductivity of the Roentgen Dose Unit.** Hermann Behnken and Robert Jaeger. *Strahlentherapie*, 1930, XXXVI, 778.

Reisner and Neeff have published the results of measurements (*Strahlentherapie*, XXXIV, 313) showing that apparently the calibrations of various ionization instruments in r-units do not agree well. The authors discuss this paper in detail and offer material demonstrating the fact that the r-unit is possible of reproduction within close limits if the measurements are conducted properly.

ERNST A. POHLE, M.D., Ph.D.

## FOREIGN BODIES

**Observation in Fifty Cases of Foreign Bodies in Air and Food Passages.** E. G. Gill. *Virginia Med. Monthly*, November, 1930, LVII, 516.

Forty-seven cases gave a history of having aspirated or swallowed a foreign body. Three cases did not have such a history. One of these had been treated for cough, pneumonia, and empyema before the X-ray showed a mattress tack in the right main bronchus. The second baby had been treated for five weeks for "colic" before the X-ray examination showed a large wire ring in the esopha-

gus. The third was a child, three years old, who was treated for six weeks for cough, pneumonia, and asthma, before the X-ray showed a carpet tack in the right main bronchus.

When a definite history of choking or coughing is given by the parents of a child, following eating or playing with objects, organic or inorganic, the case should be considered one of a foreign body until proven otherwise by every diagnostic method at our command.

W. W. WATKINS, M.D.

**A Molar Tooth in the Left Lower Bronchus.** David H. Ballon. *Canadian Med. Assn. Jour.*, December, 1930, XXIII, 821.

This is a case report of a patient who had seven teeth extracted under general anesthesia. On coming out of the anesthetic he coughed spasmodically and told the dentist he had swallowed something, because he felt a tightness in the chest. Two days later he became very ill with symptoms of lung abscess. The X-ray examination showed a tooth in the left lung. Under gas and ether anesthesia the tooth was removed. Recovery was uneventful.

L. J. CARTER, M.D.

**Missed Intra-ocular Foreign Bodies: Report of Cases.** Barton J. Powell. *California and Western Med.*, October, 1930, XXXIII, 733.

After discussing foreign bodies in the eye in general and the tolerance of the eye to many of these, the author reports several cases in which foreign bodies were present for a number of weeks.

The author summarizes as follows: "There should be frequent use of the magnet and X-ray, not only to detect the presence of a foreign body, but also as a safeguard against probable charges of malpractice and neglect. And, lastly, make intelligent use of that most valuable localization apparatus, perfected by that grand old master, the late William M. Sweet."

F. B. SHELDON, M.D.

## GALL BLADDER (NORMAL AND PATHOLOGICAL)

**Cholecystitis and Cholecystography.** Hugh Smith. *Southern Med. Jour.*, October, 1930, XXIII, 929.

This author reports his experience in a study of 150 patients by the use of dye intravenously. He first used the dye by the oral method, with tablets and capsules, but the results were so unsatisfactory that the intravenous technic was adopted, and since the improvements in oral technic he has not seen fit to return to the former method. Of the 150 patients, 94 were considered as pathological. Fifty have been operated upon, and a diagnosis was confirmed in 48, so that the pre-operative diagnosis has been confirmed in 96 per cent of the cases. The two errors in diagnosis were both found to have duodenal ulcers, and the failure of the gall bladders to empty is believed to have been due to pylorospasm, with prolonged gastric retention of the fat meals. The dye is given at the office at 9 A. M., and films are made at five hours and again at eight hours, with a fatty meal between.

W. W. WATKINS, M.D.

**Cholecystography: An Analysis after Six and One-half Years' Application.** Sherwood Moore. *Jour. Am. Med. Assn.*, Dec. 27, 1930, XCV, 1957.

The underlying physiologic and radiologic principles of cholecystography have altered little since 1923. There have been certain changes in views or detail of methods and other points. The author discusses these and epitomizes the sum of the experience of himself and his co-workers.

Phentetiothalein sodium-N.N.R. (phenol-tetraiodophthalein sodium) is preferred. In addition to being an effective test of liver function, this dye is less toxic than others. It produces a more desirable cholecystogram, with a smaller quantity of dye. The use of substances other than the halogenated phenolphthaleins for visualizing the gall bladder have not proved practical in their hands. In general, whatever the dye employed in cholecystography, accuracy demands that it be

given intravenously, for a known quantity of the substance must reach the circulation if the resultant gall-bladder image is to be exactly evaluated. The routine of administration is given in detail. Oral administration, in their hands, has been employed for diagnostic purposes only in special cases, in which the symptoms are insufficient to warrant the intravenous procedure, or occasionally in an obese subject when there is difficulty in finding a vein suitable for puncture. Their experience has been that more subjective discomfort (usually in the alimentary tract) follows the oral than the intravenous administration of the dye. Vomiting and diarrhea raise a doubt as to whether or not sufficient dye is absorbed from the alimentary tract to give dependable data as to its concentration in the gall bladder. Phenothiothalein sodium is valueless as a test of liver function when given orally, because the quantity of dye absorbed is unknown. Cholecystographic estimation of the condition of the gall bladder is based on the fact that the normal organ receives the dye, concentrates it, alters in size (or shape), and finally evacuates its contents. This sequence can be assured only if the organ is at rest during the foregoing cycle. A diseased gall bladder has its functions interfered with, and the departure from normal behavior is proportional to the degree of impairment of the organ. The test reveals anatomic changes only coincidentally or inferentially.

The fat meal is not used for testing the emptying capacity of the gall bladder, experience indicating that if the organ is visualized it will empty itself; also, that any impairment of its wall that might affect the organ's ability to void its contents would have as concomitants obvious deviation from the normal cholecystographic behavior. In disease of the liver, of such extent that the gall-bladder function is affected, there would scarcely be occasion to attempt cholecystography, as the diagnosis would probably be obvious. Acute disease of the biliary tract is a contra-indication to cholecystography. In pericholecystitis of intrinsic origin, there is a total absence of the concentrating function of the gall bladder. In pericholecystitis of extrinsic origin, there is an approximately normal concentrating

function of the gall bladder, with rarely demonstrable deformity or fixation of the organ. Pericholecystitis is dealt with at length for the reason that it has many pitfalls in cholecystographic interpretation.

There is a type of stone found in the gall bladder with normal function which is not otherwise discernible, the so-called negative or cholesterol stone. Because of the experience with calcified stones, radiographic search for them precedes cholecystography. Low in the scale of accuracy of pre-operative diagnosis is the cholecystogram which reveals a gall bladder with a deficiency of the concentrating function, having a "thin" or "faint" shadow. The persistence of the shadow beyond a twenty-four-hour period is so dependent on food intake and activity that its diagnostic importance has dwindled virtually to the vanishing point. The gall bladder that is promptly visualized, concentrates the dye, and empties without delay in the oral method is a normal gall bladder. Any deviation from this behavior, when the oral test is employed, should be followed by an intravenous test.

CHARLES G. SUTHERLAND, M.D.

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**Biliary Tract Visualization with Radiopaque Oils.** Richard H. Overholt. Surg., Gynec. and Obst., January, 1931, LII, 92.

The use of radiopaque solutions to define the biliary ducts after a drainage operation has proved of sufficient value during the past year to warrant the publication of the results of such a procedure. The more limited the exploration at the time of operation the greater this uncertainty. A definite knowledge of the patency of the biliary duct system is required in the proper post-operative management of the case, such as the determination of the time for withdrawal of the T-tube, and in giving a prognosis as to the probability of a persisting biliary fistula. The determination of obstruction of the common duct before the T-tube is withdrawn is also important if a second operation is required, as the common duct is more easily located if the T-tube is left *in situ*.

There are various indirect ways of gaining

information about the condition of the common biliary duct after operation. However, in some patients these criteria are not reliable. During the second or third week after operation, the patient is placed on an adjustable fluoroscopic table. The gall-bladder drainage tube or common duct tube is then injected with the opaque material, under fluoroscopic control, the amount varying from 15 to 20 cubic centimeters, depending upon the manner in which the biliary system fills. No force is required to make the injection as the solution will practically run into the ducts by the force of gravity.

Campidol (iodized rapeseed oil) was found to be a safe and satisfactory visualizing medium. When a complete or partial obstruction of the common duct was noted, the drainage tube was clamped following the injection, and fluoroscopic examinations made at intervals over a period of from 30 to 40 minutes. In some a duodenal tube was passed, and a solution of magnesium sulphate was injected. In no instance was there an untoward result following the injection of the biliary system. In the patients in whom no obstruction to the emptying of the common duct existed, the campidol passed immediately through the duct and into the duodenum. At times the flow of the oil would be checked at the ampulla momentarily, during which interval, waves in the common duct seemed to sweep the oil toward the hepatic ducts, before it would enter the duodenum. In such cases, however, the hepatic ducts filled poorly and the common duct incompletely. Roentgenograms showed the opaque medium scattered in the upper jejunum. It is well, for this reason, to make a large enough exposure to include both upper quadrants of the abdomen.

When an obstruction existed in the common duct, this duct as well as the hepatic ducts promptly filled and were clearly visualized. The position, contour, and size of these ducts were clearly determined. Incomplete common duct obstruction in some cases was evidenced by a filling of the duct system, with only small expulsions of oil into the duodenum. When contraction waves were seen in the common duct, with obstruction present,

there was a tendency for the opaque medium to be forced higher in the hepatic ducts.

The injection of a cholecystostomy drain, with obstruction of the common duct, showed the gall bladder, cystic and hepatic ducts. If there was no obstruction, the gall bladder and ducts filled poorly and immediate entrance of the campidol into the duodenum was noted. This information was especially important as it was in such cases that exploration at the time of operation was unwise. In cases in which the common duct obstruction had existed for a long period of time, a dilatation of the hepatic ducts could be demonstrated. In the author's cases the degree of hepatic duct dilation corresponded closely to the degree of liver drainage as estimated by the biliary output, the change in the Van den Bergh reaction, and the duration of the convalescence.

D. S. CHILDS, M.D.

#### GASTRO-INTESTINAL TRACT (DIAGNOSIS)

**On Great Gastric Retention and Dilatation of the Stomach in Cases of Gastroduodenal Ulcer and Cancer of the Stomach.** T. Klason. *Acta Radiologica*, 1930, XI, Fasc. 4, No. 62, p. 444.

The author analyzes his cases of gastroduodenal ulcer and gastric carcinoma seen in the past five years. Of 451 cases of ulcer, 258 were duodenal, and 193 were gastric. He found gastric retention in 11 per cent of the duodenal ulcers and in 5.7 per cent of the gastric ulcers. Of the 201 cases of gastric carcinoma, retention was found in 14.3 per cent, being, of course, most common in the antral lesions. The author calls attention to the fact that in obstructing carcinoma of the pyloric end of the stomach the tumor is better demonstrated at four hours than immediately after the barium meal.

M. J. GEYMAN, M.D.

**Acute Ulcerations of the Stomach in Children.** Benjamin Rice Shore. *Ann. Surg.*, August, 1930, XCII, 234.

A female infant, aged 22 months, had frequent vomiting for thirty-six hours. It died at operation, with an acute perforated ulcer-



tion of the stomach wall, the ulcer being situated on the posterior wall near the fundus of the stomach. There were no signs of chronic ulcer present. The markedly hemorrhagic edges of the necrotic area suggest that the primary lesion was one of hemorrhage, either from local injury, overdistention, or vascular thrombosis, and that gastric digestion in this area caused the perforation.

The etiology of acute ulcers is discussed. Congestion, embolism, thrombosis, vascular disease, direct injury to the mucosa, and nervous influences are considered.

F. B. MANDEVILLE, M.D.

**Gastric and Duodenal Ulcers.** L. O. Nordstrom. *Jour. Kansas Med. Soc.*, September, 1930, XXXI, 316.

The diagnosis of peptic ulcers in well developed and uncomplicated cases is comparatively easy, but in early cases and when complications cloud the picture, diagnosis is often most difficult. Roentgen-ray examinations are positively necessary for a correct diagnosis. Not only may a positive diagnosis of ulcer be made when a niche is present, but definite information as to the size, shape, position, and motility of the stomach, may be gained.

W. W. WATRINS, M.D.

**Contribution to the Knowledge of Ulcer of the Extra-bulbar Portion of the Duodenum.** Rodolfo Viviani. *La Radiologia Medica*, June, 1930, XVII, 698.

A survey of the contemporary literature discloses very few references to ulcers of the extra-bulbar portion of the duodenum. The author reports the radiological examinations of four cases. The main difficulty encountered in the clinical diagnosis of this lesion is the lack of characteristic symptoms which would indicate its exact position. The radiological manifestations are, instead, fairly well determined. The author, after a detailed study, is led to the following conclusions:

(a) The positive signs of the ulcer are: (1) ulcer niche; (2) general deformity of the duodenum, consisting of a stenosis around the orifice of the niche and of a disappearance of the shadows of the duodenal ridges; (3) the

presence of a spasm in front of the image of the ulcer.

(b) A diverticular image of the extra-bulbar portion of the duodenum may be interpreted as an ulcer and differentiated from other affections when a complete study is made of the alterations of the walls of the intestines.

(c) Although the niche is the most significant of the radiological signs, other anomalies of the duodenum may disclose peculiar characteristics of an ulcerative process. In doubtful cases, however, a positive diagnosis must be supported by clinical symptoms.

(d) The analogies existing in the radiological images of the alterations of the different portions of the gastro-enteric tube, in which an ulcer may be located, show how the intestinal canal responds, with constant and peculiar pictures, to the anatomic condition of the area affected.

(e) The fact that an ulcer of this portion of the duodenum is not so rare an occurrence as is frequently thought ought to lead the radiologist to an accurate and systematic study of the entire duodenal area.

L. MARINELLI.

**Peptic Ulcers: Diagnosis and Treatment.** Philip King Brown. *California and Western Med.*, November, 1930, XXXIII, 804.

The author discusses the etiology, medical treatment, subjective symptoms, and particularly the value of the X-ray in diagnosis and treatment. When the X-ray reveals a typical deformity, with a six-hour retention, and there is a characteristic history of pain after food, with occult blood in a milk residue stool, the author believes it is foolish to say nothing is wrong. When, with a clinical and X-ray diagnosis of ulcer, the surgeon complains that he has failed to find the ulcer at operation, the case has not been properly studied or the operation properly conducted.

Retention, evidenced by distress, lack of appetite, loss of weight, nausea, vomiting, etc., and confirmed by the X-ray, does not necessarily call for surgery. Cleaning out such a stomach and the Lenhartz diet will usually steadily reduce the retention. The author's plan is to re-check in twelve days, with grad-



ually increased diet. As much as a 50 per cent retention from ulcer has disappeared in that time. A few cases, not good operative risks, have had the rest and diet continued a month or even more, and he is gratified to find that it is worth while often enough to give it serious consideration.

F. B. SHELDON, M.D.

**Syphilis of the Stomach—A Study of Eight Cases.** John B. Fitts. *Ann. Int. Med.*, December, 1930, IV, 628.

During a period of eight years there were 35,000 patients admitted to the hospital, with eight cases of gastric syphilis.

The X-ray signs of gastric syphilis are as follows:

1. A concentric, symmetrical defect of the gastric lumen.
2. The stomach appears high, with narrowed lumen.
3. If the lesion is antral, it appears in a narrowed tubular effect.
4. If the lesion is of the hour-glass type, the isthmus of the hour-glass is elongated and dumbbell-like.
5. The pylorus may be gaping, or, less frequently, obstructive.
6. Six-hour residues are found only in the obstructive type.
7. The technical point of differentiation from carcinoma lies in the fact that the syphilitic lesion is symmetrical, while the carcinomatous is asymmetrical and irregular.

Syphilis may involve the stomach in three ways, namely, (1) diffuse syphilitic gastritis; (2) syphilitic ulcer; (3) gummatous infiltration. The symptoms present in gastric syphilis are pain, vomiting, loss of weight, positive Wassermann, and characteristic X-ray findings.

C. H. DEWITT, M.D.

**Psychogenic Factors in the Etiology of Ulcerative Colitis and Bloody Diarrhea.** Cecil D. Murray. *Am. Jour. Med. Sci.*, August, 1930, CLXXX, 239.

In this article, the author reviews a series of 12 cases of ulcerative colitis and bloody diarrhea, with special reference to psychogenic

factors in their etiology. He cites a number of cases in which there is a rather startling relation between the onset of the disease and the outbreak of emotional disturbance, the first mucus shreds or the first blood appearing in the stools at times of emotional stress. He gives complete histories of four cases in which this relation was most striking that tend to show how serious the physical condition may become in one or more of the following circumstances, namely: (1) if the emotional conflict is deep-seated or chronic or not easily settled; (2) if there is a specific organism, and, vague though it is, we must add, (3) if the individual is predisposed in some way by heredity, early training, general physical or nervous makeup, etc., to colon afflictions.

He compares this last to the fear component in cases of gastric ulcer, emphasized by Draper and McGraw (*Am. Jour. Med. Sci.*, 1927).

The outstanding trait in colitis patients besides fearfulness is their emotional immaturity, and in this respect they differ from the gastric ulcer individuals.

The author finds that mental conflicts concerned with marriage were more commonly found than other types of situations which might evoke anxiety. In each case, the patients faced their problems in an inadequate, infantile manner. He feels that if the pathologic process has not progressed too far, a thorough investigation into the patient's life and mental attitude may afford opportunity for much needed psychotherapy.

ROE J. MAIER, M.D.

**The Irritable Colon.** John Muir. *British Jour. Radiol.*, September, 1930, III, 391.

The author attempts to show that evidence of gastric irritation may be found not merely with such extrinsic causes as pathologic gall bladder, appendix, etc., but that the same finding may be co-existent with no extrinsic organic lesion, but only a similar state of irritation of the colon. Localized pylorospasm is considered more significant than generalized hypertonicity or hyperperistalsis, as regards colon irritability. The signs of irritable colon are given as follows: (1) tenderness distrib-

nted along the course of the colon, often accentuated over the middle of the transverse or over the descending portions; (2) exaggerated and irregular haustration or segmentation; (3) inconstant dilatation of the proximal colon, and (4) by enema study of hypermotility through certain segments, most often the pelvic and descending portions. The author urges caution in the interpretation of irritability of the colon, since there are such wide variations within normal limits, but at the same time calls attention to the extreme variability of the roentgen findings as the clue to absence of organic intrinsic lesions and the presence of irritability only.

J. F. HABBE, M.D.

**The Roentgenologic Demonstration of a Gastric Myoma.** Hans Gebhardt. *Röntgenpraxis*, Oct. 15, 1930, II, 913.

The diagnosis of benign tumors of the stomach has been greatly furthered by the roentgenologic examination, using small amounts of barium, and compression. It is possible to reach a diagnosis of a benign gastric tumor in quite a number of cases by this examination, especially if one observes the behavior of the surrounding mucosa. A case is described in detail which presented a definitely outlined, well circumscribed, round filling defect in the corpus of the stomach, with a normal mucosa surrounding it. Operation proved that this tumor was a myoma.

H. W. HEFKE, M.D.

**Radiological Diagnosis of Duodenal Ulcer.** Paolo Buisson, Marco Bermond, and Mario Buisson. *Minerva Medica*, April 14, 1930, I, 599.

The most reliable method to adopt for a diagnosis of duodenal ulcer is a series of radiographs. Fluoroscopy, while not entirely satisfactory, is superior to any clinical examination and is to be considered, in some cases, as a supplement to radiography.

The authors analyze the fluoroscopic factors (gastric hypertonia, Kreuzfuchs' sign, pyloric insufficiency, temporary spasm of the pyloric region, etc.) which may be noted in a case of

duodenal ulcer. They point out the inadequacy of such examination by discussing other gastric affections which would present the same fluoroscopic characteristics. Clinical examination and history are to be resorted to only when more factors of differentiation are needed because they cannot, by themselves, supply any definite criterion except for the most evident cases.

As for radiographic signs, it is advisable to consider two series. The first shows a pathological stage of the pyloro-duodenal region, but it cannot lead to an unquestionable diagnosis. It consists of such anomalies as eccentric position of the pylorus, with respect to the duodenal bulb, the pyloro-duodenal "dextro-fixation," and the bulbar ante-position *et similia*. The second series consists of the positive pathognomonic signs of duodenal ulcer, namely, the niche, the cicatricial deformation, Akerlund's pseudo-diverticulum, and the "enchoche" or "bulbous defect." The authors consider the persistency of the shape and position of these images as the most reliable factors, and illustrate their detailed discussion by reporting 21 cases (out of 300 studied), with an extensive radiographic repertoire.

L. MARINELLI.

**X-ray Examination in Acute Intussusception.** Einar Edberg. *Acta Radiologica*, 1930, XI, Fasc. 2, No. 60, p. 194.

For twenty years the author has been interested in intussusception, but only in the last two years has he employed the X-ray examination in selected cases. The higher the intussusception, the more difficult is the diagnosis by opaque enema. The author's experience is that in pure ileal intussusception it is very hard to make any other pre-operative diagnosis than intestinal obstruction. He has found Meckel's diverticulum involved in a number of these cases.

Intussusception of the colon was the first form to be described from the roentgenographic viewpoint. Edberg feels the X-ray examination is of no great value in acute intussusception of the colon, but of much usefulness in chronic colic intussusception in adults. Seventy-five per cent of all intussus-

ceptions occur in children, and 75 per cent of these are in the vicinity of the ileocecal junction. The author describes two main types: (1) the ordinary ileocecal intussusception and (2) a variety which he terms the ileo-ileocolic. At X-ray examination one sees the head of the intussusceptum and the central column of barium mixture filling the outer column as a piston fills the barrel of a syringe. In ileocecal intussusception there is ordinarily a shell-shaped filling defect in the opaque column in the region of the invagination. The head of the intussusceptum may pass far into the colon. The colon distal to the lesion is usually tubular, with decreased haustrations. There is likely to be comparatively little accumulation of gas in the small intestine, even though ileus has existed for some time.

In ileo-ileocolic intussusception, the primary invagination occurs in a loop of the terminal ileum, and at first only the small intestine is involved. Usually this type of intussusception does not pass as far into the colon as the common ileocecal form. The invaginated part has more room than in the ileocecal type, and the peripheral portion looks like a stocking drawn over the swollen invagination. The opaque enema can pass between the middle and outer cylinders of intestine. The haustrations are small. The lower colon is tubular, but near the intussusception one often sees a beautiful relief of the mucous surface of the bowel. As a rule, there is more gas in the small intestine than in the ileocecal intussusception and meteorism appears much earlier.

The author states that he has compared the fluoroscopic appearance, the roentgenograms, and the operative findings in his cases, and that as a result he feels that a differentiation between ileocecal and ileo-ileocolic intussusception can be made by the X-ray examination. The importance of this is better understood in view of the fact that early ileocecal intussusception may often be reduced mechanically, whereas the ileo-ileocolic type should be operated upon immediately.

The author has been interested in attempts at reduction by barium enema. He has seen three cases of early ileocecal intussusception rapidly and completely reduced by the opaque

enema. One of these patients was explored 24 hours after the reduction, and characteristic residual swelling and edema were found in the cecum. Another case showed almost instantaneous reduction of an intussusception that screen examination had shown to have reached the hepatic flexure; when symptoms recurred within a week, an operation was performed which disclosed a diverticulum in the terminal ileum and fixation of both the cecum and appendix. The fixation of the cecum prevented cecal invagination but permitted ready prolapse of the diverticulum into the colon. Cases of this sort may allow invagination of the ileum into the colon for a considerable distance; reduction is usually easy. Edberg has seen partial reductions under the screen which were not permanent.

At the end of the article the author reports 11 cases, 9 of which are under one year of age. Only one of the patients succumbed. The clinical history, roentgenograms, and operative findings are given in each instance. He concludes as follows:

(1) Simple ileocecal intussusception on roentgenograms shows a wide, shell-shaped filling defect in the barium enema at the site of the lesion, and only a small amount of gas in the small intestine even after a relatively long illness.

(2) Ileo-ileocolic intussusception shows the opaque medium in a thin layer about the intussusceptum, and gives the impression of an irregular, spiral filling defect in the barium column. The mucosal folds in the wall of the colon are visible. There is more gas in the small intestine than in the ileocecal type.

(3) When the primary intussusception occurs only a few centimeters from the ileocecal valve, a secondary invagination of the cecum occurs, and the roentgenographic appearance resembles that seen in ordinary ileocecal intussusception.

A. L. HART, M.D.

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Stasis of the Cecum and Ascending Colon.  
L. D. Johnson. *Jour. Kansas Med. Soc.*,  
September, 1930, XXXI, 322.

Many patients complaining of pain in the right lower quadrant submit to operation with-

out obtaining relief. Many such cases are due to obstruction or stasis in the proximal colon, usually from some congenital defect, and the cecums are occasionally found to be greatly distended at the dependent part, containing a double band. There is usually a history of prolonged low-grade pain in the right iliac fossa, extending up to the right costal margin. Reflex stomach symptoms are frequent, such as nausea, epigastric pain, acid eructations, etc. The X-ray will tell the whole story. From 6 to 10 hours after a barium meal, the opaque material will be in the cecum, where it stays for from 48 hours up to several days. One case was observed in which it remained in the cecum for 14 days. The cecum and ascending colon cannot be emptied on palpation and the area of obstruction may be visualized. In patients who have previously had appendectomies and the symptoms still remain, the X-ray examination gives the same picture.

W. W. WATKINS, M.D.

**The Clinical Diagnosis of Hypertrophic Syphilis of the Stomach.** Heinz Baumecker. *Med. Klinik*, Oct. 17, 1930, XXVI, 1557.

Syphilis of the stomach is a rare disease. It is seen in approximately only one out of ten thousand autopsies. The clinical diagnosis is very difficult. Symptoms from the stomach and a positive Wassermann reaction do not constitute enough evidence for this diagnosis. The roentgenologic findings are by no means so characteristic that one can depend on them. According to Carman and Hartwell, syphilis of the stomach should be suspected if the marked roentgenologic changes are out of proportion with a slight cachexia and anemia. Either an ulcer or a carcinoma (especially the scirrhus type) can give the same appearance as syphilis. The disappearance of clinical and roentgenologic findings after specific therapy, taken by some authors as proof, can be explained as caused by the diet régime, and self-healing of ulcers. Many cases of so-called syphilis of the stomach are not proved. The case of a thirty-two-year-old woman is described in detail. The roentgenologic diagnosis was carcinoma of the stomach. How-

ever, a laparotomy and a biopsy showed a chronic inflammatory lesion which was considered to be syphilitic.

H. W. HEFKE, M.D.

**The Reaction of the Content of the Gastro-intestinal Tract.** Frank C. Mann and Jesse L. Bollman. *Jour. Am. Med. Assn.*, Dec. 6, 1930, XCV, 1722.

The various digestive enzymes that are poured into the gastro-intestinal tract require different chemical reactions of the gastro-intestinal content for optimal activity. These reactions vary from one definitely acid for the stomach to one neutral or slightly alkaline for the remaining portion of the gastro-intestinal tract. The changes in reaction of the gastro-intestinal content, as it passes through the gastro-intestinal tract, necessitated because of the needs of the various enzymes, have formed the basis for many physiologic problems and have offered the possibility for the development of certain pathologic conditions. The actual changes in the acidity of the gastro-intestinal content and following various diets are in themselves of considerable physiologic value. The mechanism whereby the changes are graded as the content passes, for instance, from the acid secretion in the stomach to the neutral or alkaline secretion in the duodenum, also raises problems of considerable physiologic significance.

Supplementing the experimental production of peptic ulcer by Mann and Williamson, it was necessary to determine whether the theoretical considerations that made possible the development of a successful method of producing chronic peptic ulcer were correct. In order to determine this, it was necessary to observe the changes in acidity taking place in the gastro-intestinal tract, particularly at the pylorus and in the duodenum, at frequent intervals, over long periods of time, in the fasting state, and following the ingestion of various types of food. An exceedingly satisfactory method was developed, and this is described in detail. Estimation of the acidity in the fasting animal showed the gastric juices usually strongly acid, but at times almost neutral.

The content of the duodenum, jejunum, ileum, and colon is usually alkaline, with the exception that the content of the duodenum may be acid when highly acid values are found in the content of the stomach. Following a meal, the acidity of the content of the gastro-intestinal tract depends largely on the development of acid in the stomach. Short periods of high acidity of content are common in the duodenum and less common in the small intestine, the greater the distance from the pylorus. The usual reaction in the small intestine, after a meal, is close to neutral. The content of the colon is usually slightly alkaline, but may be slightly acid, especially following a meal rich in carbohydrate. Dietary measures may greatly alter the acidity of the content of the gastro-intestinal tract.

C. G. SUTHERLAND, M.D.

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**The Roentgenologic Appearance of a Subphrenic Abscess on a Post-appendiceal Basis.** Oskar Meller. *Röntgenpraxis*, Dec. 1, 1930, II, 1071.

The clinical diagnosis of a subphrenic abscess is often very difficult to make. A roentgen examination may be of great value. A high diaphragm, gas under the diaphragm, and a fluid level which shifts with the position of the patient, are findings which permit a definite diagnosis. Occasionally one may demonstrate a deformity of the hepatic flexure of the colon by means of a barium enema, indicating a contact of the abscess with the wall of the colon.

H. W. HEFKE, M.D.

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**Acute Intestinal Obstruction.** Irvin Abell. *Jour. Am. Med. Assn.*, Dec. 20, 1930, XCV, 1903.

A study of accumulated statistics reveals that, while acute intestinal obstruction carries an inevitable mortality, the greater portion of the mortality may justly be attributed to delay in recognition and to tardiness in the institution of appropriate surgical treatment. The underlying fact, with which all adjuvants must be correlated, is that the obstruction is mechanical and must be corrected me-

chanically. The presence of abdominal pain, vomiting, and constipation, with an absence of fever and leukocytosis, should put the burden of proof on the medical attendant to show that no obstruction exists. The flat roentgenogram, interpreted by a competent roentgenologist, in addition to the three cardinal symptoms mentioned, should permit of a working diagnosis before the accession of fever, leukocytosis, distention, and paresis indicate changes brought about by strangulation and chemical changes of the blood show profound alterations.

In the discussion of a series of papers, Case interestingly discussed the technic of the roentgenologic demonstration of acute intestinal obstruction by the flat film and the administration of a small quantity of barium in a dextrose-water mixture by mouth to visualize the small intestine.

C. G. SUTHERLAND, M.D.

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**Gastric Ulcer with Gastritis in a Ten-year-old Child.** Franz Herz. *Röntgenpraxis*, Dec. 1, 1930, II, 1077.

Gastric ulcers in children are rare. Such a case in a ten-year-old child is described, with special reference to the roentgenologic findings. A crater could be demonstrated at the lesser curvature, close to the cardia.

H. W. HEFKE, M.D.

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**The Diagnosis of Gastric Lesions by Intra-gastric Photography: Preliminary Report.** Reuben Finkelstein. *Ann. Int. Med.*, January, 1931, IV, 804.

While lesions along the curvatures are readily diagnosed by the X-ray examination, lesions of the walls are more difficult, or impossible, of diagnosis.

The development of intra-gastric photography makes possible an accurate diagnosis of lesions which would otherwise be difficult of diagnosis.

The gastro-photor consists of a semiflexible tube carrying at its distal end a double camera, an upper and a lower, between which is a small electric bulb so constructed that when activated by a transformer it yields a bluish-

white light of 12,000 candle power for 1/120 of a second, and is then destroyed. The transformer takes its energy direct from the house-lighting current.

Each camera contains four small films regularly disposed in a circle, and by means of two pinpoint holes, upper and lower, a stereoscopic picture is taken by each film of a 90-degree arc of the circumference; thus at each exposure eight double stereoscopic views are taken. Films are marked so that one can tell what part of the circumference of the stomach is shown on the film. A full description of the technic employed is given. The author arrives at the following conclusions: "Like all other means of diagnosis it is not infallible, and will not replace the X-ray or clinical evidence of gastric disease. There are, however, a large number of cases in which the diagnosis cannot be made and only a gastro-photor picture will reveal the lesion."

C. H. DEWITT, M.D.

**A Contribution to the Diagnosis of an Obstruction in the Upper Small Intestines.** C. Wittkowsky and Metzger. *Röntgenpraxis*, Nov. 15, 1930, II, 1042.

A case of an adenocarcinoma of the jejunum is reported on account of the rare occurrence of such tumors. The roentgenologic examination showed a definite but incomplete obstruction and dilatation of the upper jejunum. Operation and autopsy confirmed the diagnosis.

H. W. HEFKE, M.D.

**Acute Intestinal Obstruction.** Frank Smithies. *Jour. Am. Med. Assn.*, Dec. 20, 1930, XCV, 1899.

When acute intestinal obstructions are suspected, roentgen studies are to be condemned if they include the employment of barium mixtures. Four patients of the author's series had X-ray progress meals administered after there had accumulated sufficient proof, clinically, that an acute abdominal lesion existed. In all instances, the stimulus of the opaque meal, combined with the weight of the digestively inert barium, resulted in the acute intestinal obstruction being converted into acute

intestinal perforation. Only one patient recovered. At times, certain valuable information may be secured by the roentgen study of gas-filled loops of bowel. In the films it may be possible to demonstrate approximately where the obstruction lies; at least, one may state, with fair accuracy, that the obstruction is in the small and not in the large bowel. There are instances in which sufficiently sharp gas shadows will enable a definite diagnosis of jejunal, in contra-distinction to an ileac, obstruction.

If roentgenographic studies can be made without loss of time and undue moving about of the patient, they should form a part of every routine examination. Not only may these "scout films" give information that is valuable diagnostically, but a study of the gas shadows may prove of great help in aiding the surgeon to better plan his operative procedure. When perforation of the bowel has already taken place, and when the patient had previously been taking medicine, such as bismuth, the shadow cast by the escaped opaque substance may indicate where the perforation is. In such circumstances, films serve as a caution against immediate operation. Proof of free-lying bismuth shown roentgenologically, suggests a waiting policy that may save the patient's life.

C. G. SUTHERLAND, M.D.

**The Incidence of Hemorrhage in Perforated Gastric and Duodenal Ulcers.** Moses Behrend. *Jour. Am. Med. Assn.*, Dec. 20, 1930, XCV, 1889.

Ulcers of the stomach and duodenum manifest themselves in various ways. They are selective in their location, time of perforation, and incidence of hemorrhage. "Perforated ulcers rarely bleed and bleeding ulcers rarely perforate." The varying degrees of morbidity caused by ulcers depend, to a large degree, on their location. The author's research findings coincided with those of Einhorn, namely: "The arteries in the submucosa in the pyloric region of the lower lesser curvature of the stomach are practically terminal vessels and are relatively sparsely distributed, giving a limited blood supply to this area. They are

tortuous, anastomose infrequently, and are subject to powerful and repeated forcible contractions by numerous interlacing, intrinsic, and frequently contracting muscle bundles. These constrictions tend to interfere with the circulation and, moreover, the terminal vessels are subject to the same tendency to circulatory interference by reason of easy blocking, as are the terminal vessels in the brain, or kidney, and are especially liable to harbor the foci of anemia."

Ulcers that give rise to hemorrhage are more apt to occur in the pliable elastic tissue of the stomach than in the dense area around the pylorus. No definite place can be assigned to this type of ulcer. There is some difference of opinion whether surgeons should or should not operate. In the author's opinion, it is an error of judgment to defer operation in hope the ulcer may not bleed again. Perforated ulcers occur more frequently than bleeding ulcers. The bleeding ulcer is usually an acute condition, hence the area affected is much smaller in extent. It is interesting to note the gross pathologic differences *in vivo* between the chronic ulcer, the perforating ulcer, and the bleeding ulcer.

C. G. SUTHERLAND, M.D.

**Sigmoidoscopy versus X-rays in the Diagnosis of Terminal Bowel Disease.** Frank C. Yeomans. *Jour. Am. Med. Assn.*, Dec. 20, 1930, XCV, 1907.

Refinements in the technic of roentgenology and improvements in proctoscopes have made these two agents prime factors in the diagnosis of gastro-intestinal diseases. Each method has its indications, advantages, and limitations, and frequently the two are materially helpful in arriving at a correct diagnosis. In the relatively fixed rectum and distal sigmoid colon, which are situated largely within the bony pelvic girdle, the X-rays are of comparatively limited value. Prominent defects are: (a) an important lesion may be missed entirely; (b) although the site and apparent extent of a lesion are discovered, especially if it is of a stenosing character, its nature is frequently not disclosed; (c) in many cases, interpretation of the image is so uncertain as to cast grave doubts on the diagnosis. For

example, amebic colitis in its early stages or before secondary infection of the ulcers has occurred, may present the same symptoms and roentgenologic appearance as ulcerative colitis, but viewed through the proctoscope, the early lesions are characteristic and pathognomonic. In examination of the terminal bowel the usual order of procedure should be reversed, sigmoidoscopy being first in order. Endoscopy usually establishes the diagnosis of lesions in the rectum and the pelvic colon. Negative endoscopic observations are valuable data for the roentgenologist. The X-ray comprises the best available agent for determining the extent of involvement in ulcerative colitis, and in detecting tuberculosis of the cecum; it is our chief reliance in demonstrating diverticulosis of the colon, and especially diverticulitis of the sigmoid, and, rarely, it may discover a double primary carcinoma in different colonic segments.

C. G. SUTHERLAND, M.D.

**A Contribution to the Roentgenologic Diagnosis of Ulcerative Colitis.** Hans J. Teschendorf. *Röntgenpraxis*, Dec. 1, 1930, II, 1087.

The roentgen examination of the colon by means of a barium enema is of great clinical significance in the diagnosis of ulcerative colitis. The results are better when the films are taken after the patient has expelled the enema, as the "relief" of the mucous membrane is more clearly demonstrated. The method of A. W. Fischer (combination of barium enema and air inflation) gives plastic pictures, but does not show the mucous membrane.

H. W. HEFKE, M.D.

**Diet in Chronic Gastric Ulcer.** Editorial. *Jour. Am. Med. Assn.*, Dec. 13, 1930, XCV, 1838.

In the words of the editorial writer: "The successful treatment and healing of gastric ulcers involves many factors of uncertainty, reflected in the multiplicity of suggestions from therapeutists. For example, a recent writer asserts that the establishment of proper habits of eating, the avoidance of notoriously



irritating articles of food which offend the gastric organ because of chemical, mechanical, or thermal insults, the minimization of worry, strain, and hurry—at least at meal times—the removal of infection from teeth, tonsils, and accessory sinuses, the prevention of chronic constipation by regulation of diet and exercise, and the surgical removal of disease elsewhere in the abdomen, are measures that tend to lower the incidence of ulcer. He adds that these are essential features in the treatment of ulcer whether or not surgery is employed. . . . Experimentation is singularly difficult in human cases: hence it is proving to be of great advantage that characteristic gastric ulcer can be developed with considerable success in experimental animals. In the latter it has been observed that relative hyperacidity and hypernormal secretion, such as are associated with partial pyloric stenosis, are not necessarily such important factors in the delay of healing as was formerly assumed."

He continues: "Mechanical factors, however, can delay the healing of an acute lesion of the gastric mucosa, and acids make the ulcer more irritable or susceptible to bleeding. Fauley and Ivy have further pointed out that coarse particles of food remain in the stomach longer than fine particles, which obviously results in more prolonged motor activity of the stomach and increases the trauma to an acute lesion of the mucosa. This would be pronounced in a patient with pylorospasm. In studies at the Northwestern University Medical School, Chicago, they have demonstrated that certain types of acute experimental lesions of the gastric mucosa are definitely harmed by a "rough" diet. For instance, a simple ulcer of the rabbit's stomach, produced by excision, heals within thirty days, irrespective of the consistency of the diet. A similar ulcer, but with a silk suture in its base, will heal if the rabbit is fed a soft diet, but will tend to become chronic if the rabbit is fed a "rough" diet. Therefore, Fauley and Ivy conclude that in chronic ulcer in man a soft diet would facilitate the healing of an ulcer, which confirms clinical experience and supports the use of a diet of the character of that employed in the generally accepted therapeutic procedures for gastric ulcer."

C. G. SUTHERLAND, M.D.

A Contribution to the Roentgenologic Diagnosis of Chronic Obstruction of the Small Intestines. G. Lemmel. *Röntgenpraxis*, Nov. 15, 1930, II, 1034.

The roentgenologic study of pathologic lesions of the small intestines has not been developed as much as in the case of the stomach, duodenum, and colon. It is necessary to examine the small intestines frequently after a barium meal, over twenty-four hours or more. A definite localization of the obstruction and its nature may thus be reached in a large percentage of the cases. The horizontal fluid level, with gaseous distention of the small intestines, fixation of some loops, and distention with barium, are all only indirect symptoms. The demonstration of the obstruction itself gives a much better chance for a precise diagnosis.

H. W. HEFKE, M.D.

Roentgen Diagnosis of Ascariasis. Vincent W. Archer and Charles H. Peterson. *Jour. Am. Med. Assn.*, Dec. 13, 1930, XCV, 1819.

In September, 1929, during a routine roentgen gastro-intestinal examination of a child, certain signs were correctly diagnosed as being caused by *Ascaris* in the intestinal tract. No reference was found in the English literature, so experimental work was started on a group of children infected with *Ascaris*. A subsequent search of the foreign literature revealed several references. The ova from polluted soil are ingested and hatch in the small intestine. The larvæ migrate through the intestinal walls, enter the circulatory system, and are carried to the capillaries of the lungs. Here they develop in the air sacs, give rise to pulmonary changes, pass up the bronchial tree, and are swallowed. After liberation from the lung, about six weeks is required for maturity. A constant supply of fresh larvæ is being supplied by the lungs, even after an anthelmintic has cleared the intestinal tract of parasites.

A series of 60 patients, with stools positive for *Ascaris* ova, were studied roentgenologically. Of 57 children, 54 showed the very definite, typical roentgen appearance to be



described. Only one of the adults showed this. Films are made at one, two, and four hours. At first there are cylindrical filling defects, especially in the jejunum, from 5 to 8 mm. in diameter, and from 15 to 20 cm. in length. Later films show string-like shadows in the central portion of the filling defect. These are interpreted as the barium-filled enteric canal of the parasite. An interesting incidental observation has been that the parasites will not ingest the barium if the patient has eaten prior to drinking the contrast meal, and consequently the enteric canals will not be outlined. Roentgen evidence is occasionally definite in the absence of ova in the stool.

C. G. SUTHERLAND, M.D.

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**The Origin of Polypi of the Large Bowel, with Especial Reference to Adenoma: Preliminary Report.** W. A. Fansler. *Jour. Am. Med. Assn.*, Dec. 27, 1930, XCV, 1969.

Polypi may occur in almost any portion of the intestinal tract, but approximately 75 per cent occur in the large bowel. Broadly speaking, any pedunculated tumor extending into the lumen of the bowel may be termed a polypus. Of the most unusual types may be mentioned fibromas, lipomas, and myxomas arising from the areolar tissue of the bowel wall; myomas, arising from the muscular coats, and hemangiomas, arising from the blood vessels. Post-sacral dermoid cysts and meningocele may arise outside the bowel and protrude into the lumen of the intestine in a polypoid fashion. Occasionally there is a polypoid growth due to parasites. A second group has to deal with the epithelium of the large bowel. A type is seen in cases of ulceration of the large bowel due to ulcerative colitis, amebic dysentery, syphilis, tuberculosis, and other inflammatory conditions. These are in no sense true tumors, as there is no growth of epithelial tissue.

A second type is the adenoma or adenomatous polyp. These tumors are true adenomas, whose epithelial structure is derived from the cells of the intestinal mucosa. They protrude into the bowel lumen and eventually become polypoid through the traction of their own weight, the pulling of

the fecal current, and the peristaltic action of the bowel itself. The adolescent (congenital disseminated) type is seen in the first two decades of life. Children usually have a single adenomatous polyp. The author has never seen a case in which the bowel was studied with numerous adenomatous polypi in a patient under 18 years of age. As a rule, single adenomas occur in the earlier years of life and multiple adenomas in the later years. It is fairly obvious that some tendency of an individual to form adenomas does exist. In some cases, a definite family tendency can be shown. Adenomas are frequently found in chronically inflamed areas, or the primary change may occur in the epithelial cells and the inflammatory change may be secondary. The fact that the mucosa adjoining the adenoma is frequently normal would point to this. The author believes that the tumor begins as an enlargement of a small submucous nodule of lymphoid tissue and the epithelium over it is normal. While the exciting cause or causes of the formation of adenomatous polypi of the large bowel are not definitely known, he is convinced that the earliest demonstrable pathologic change is not found in the areas of the mucosa lining the bowel, but as a nodule of lymphoid cells in the submucosal tissue.

CHARLES G. SUTHERLAND, M.D.

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## GASTRO-INTESTINAL TRACT (THERAPY)

**Visceroptosis: Its Clinical Significance and Treatment.** Edward L. Bortz. *Am. Jour. Med. Sci.*, July, 1930, CLXXX, 59.

In 1885, Franz Glénard first described the condition now known as visceroptosis. Since that time numerous articles have appeared in the literature, emphasizing the importance and various phases of this condition.

The author has analyzed 100 cases, according to age, incidence, sex, chief complaints, physical findings, previous operations, organs involved, accompanying lesions of the pelvis, additional diagnoses, important factors in the production of visceroptosis, probable important factors in the production of symptoms, re-

sults of treatment, and complicating factors in unimproved cases. He has also analyzed the opinions of twenty leading radiologists in four different countries.

He arrives at the following conclusions:

(1) Visceroptosis is a condition of downward displacement of the abdominal viscera that may exist in individuals who appear to be in perfect health.

(2) The condition may be primary, that is, hereditary, or it may be acquired following somatic devastation from overwork, repeated pregnancies, prolonged disease, etc.

(3) In a series of 100 cases studied in the Lankenau Hospital Medical Clinic the chief symptoms have been analyzed here. They usually pointed to the gastro-intestinal tract.

(4) Satisfactory therapeutic measures depend upon a consideration of the cause of the symptoms.

(5) In the Lankenau Clinic a definite daily program is planned for each patient including proper diet, elimination, rest, massage, and, when indicated, mild sedatives. All foci of infection are eradicated and, in selected cases, a Page abdominal support is applied. In a small percentage of cases requiring surgical intervention the fundamental *rationale* of the treatment should not be neglected.

ROE J. MAIER, M.D.

**Subtotal Gastrectomy for Duodenal Ulcer: Ten Years' Experience and Clinical End-results.** Alfred A. Strauss, Leon Bloch, J. C. Friedman, Jacob Meyer, and Morris L. Parker. *Jour. Am. Med. Assn.*, Dec. 20, 1930, XCV, 1883.

This study is based on the results of 221 subtotal gastrectomies for duodenal ulcer. It represents the combined opinions of a stomach-study group, composed of surgeons, internists, roentgenologists, pathologists, research fellows, and a member of the social service department. The latter member studied the economic conditions of peptic ulcer patients before and after medical treatment, as well as before and after operation. All chronic gastric ulcers should be treated surgically because of the difficulty of deciding whether or not a gastric lesion is an ulcer or beginning carci-

noma, and of the possibility of fatal, or near fatal, hemorrhage. Every duodenal ulcer should have the benefit of at least one thorough medical treatment, irrespective of the patient's economic condition. In cases in which the ulcer is not bleeding or perforating, the patients are usually relieved of their symptoms after two weeks' rest in bed and the usually accepted routine medical management. If the roentgen examination shows a clover-leaf deformity of the duodenum, little can be expected from medical treatment. The majority of these are due to an ulcer on the posterior duodenal wall, perforating into and adherent to the pancreas. Experience has shown that these ulcers do not heal, as the patients suffer not only from the ulcer but from mechanical difficulties. Pathologically, in addition to the duodenal ulcer, there is often associated a cholecystitis and pancreatitis, aside from gallstones.

The authors have formulated two basic laws for the successful surgical treatment of ulcers: (1) That the pathologic tissue should be removed, including the first portion of the duodenum and the lower half of the stomach; (2) that the stomach must have a rapid, or quicker than usual, emptying time. Subtotal gastrectomy, in their opinion, is the only operation which fulfills these laws. The mortality in their series of surgical cases was 5.4 per cent. The clinical end-results showed 95 per cent symptom-free on no particular diet or medication, and the gain in weight has been from 15 to 50 pounds.

CHARLES G. SUTHERLAND, M.D.

**The Results of Medical Treatment of Peptic Ulcer.** Ralph C. Brown. *Jour. Am. Med. Assn.*, Oct. 18, 1930, XCV, 1144.

The forms of treatment, in general, used prior to 1915 were chiefly based on bland foods, rest in bed, hot fomentations, and minimal doses of alkalis. Sippy recognized the important influence of the digestive action of gastric juice on the unprotected raw surface of a gastric or duodenal ulcer. He advanced the theory that healing of peptic ulcer could best be achieved by elimination of the chemical digestive action. He suggested neutrali-

zation of free hydrochloric acid in the gastric content from breakfast until bedtime, with special emphasis on the control of any existing hypersecretion during the night hours. The application of this theory resulted in the hourly-feeding schedule and the intensive use of alkalis of various types.

Two facts have emerged from continuous clinical experience with ulcer-bearing individuals. First, that by far the greater proportion of gastric and duodenal ulcers can be healed by proper medical measures. Second, that these lesions tend to recur, either at the original site or in a different area of the stomach or duodenum. A survey has been made of all cases treated by Sippy and the author over a period of fifteen years. Questionnaires were sent to 1,900, and the replies made possi-

ble a study of 1,224 cases. The clinical data are reviewed; the roentgen data were available in only 1,036 cases. Duodenal ulcer was diagnosed in 923 cases, gastric in 77, and duodenal and gastric in 12. Of the 1,130 cases treated medically, 49.5 per cent were reported cured; 16.7 per cent satisfactorily improved, and 10 per cent moderately improved. In 20 per cent medical measures failed. Approximately 20 per cent of the patients with gastric and duodenal ulcers now being admitted to hospitals require surgical care. Because of the lack of basic knowledge regarding the etiology of ulcer, the inability of physicians to insure an ulcer-bearing individual against recurrence constitutes the most serious problem to be faced.

C. G. SUTHERLAND, M.D.

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# The Story of Stabilized Valve Tube Rectification

For a long time Keleket engineers have been experimenting with valve tube type of rectification. Various models of equipment were built and tested, however, none was placed on the market, due to the fact that the designs were more or less conventional and, for that reason, had the limitations of valve tube rectified apparatus as it was then known. Until such time as definite improvements could be presented over existing designs and until the fallacies were corrected or eliminated, the Kelley Koett Company recommended Mechanically Rectified Apparatus to its customers.

The difficulties present with conventional designs were—firstly, the inability of the operator to calibrate his equipment with a sphere or spark gap after installation, secondly, there was no method of automatically controlling the filament temperature of the valve tubes used for rectification, and thirdly, the current output of such apparatus was about half that permissible with Mechanically Rectified Equipment.

It is well to be able to measure the voltage output of an X-ray machine in order that the operator may know the exact maximum voltage stress placed across an X-ray tube.

Automatic control of the filament temperature of rectifying tubes is essential because the lack of this feature may cause the shortening of the valve tube life.

The basic design of a valve tube is similar to that of an X-ray tube—that is, it has a heated filament providing a source of electronic emission and a target or anode, on which this electronic emission is focused. A valve tube differs from an X-ray tube in that the filament is much larger, thereby providing an abundant source of electronic emission, and the resistance of the tube becomes negligible to passage of current in the proper direction.

A valve tube which does not have the filament heated to a certain necessary degree of temperature will take on the characteristics of an X-ray tube. This is evident—firstly, by an increased voltage drop across the tube and less voltage output to the X-ray tube; secondly, by the heating of the target of the valve tube caused by the high speed bombardment of the target by the electronic stream; and thirdly, the tube becomes excessively hot and no longer rectifies but passes alternating current which will immediately cause destruction of the adjacent valve tube in the rectifying circuit, likewise possible destruction of the X-ray tube.

In an attempt to compensate for the foregoing valve tube limitations, conventional equipment was designed with a variable voltage regulator to control the heat of the filaments in the valve tubes. This control was necessary, because should the apparatus be operated at a high current, the accompanying voltage drop of the line would drop the heat of the filaments in the valve tubes, thereby causing tube injury. To correct this the heat of the filaments of the tubes was increased beyond normal so that when a drop in voltage came there would be sufficient heat for the proper operation of the valve tubes. The falseness of this procedure is evident, due to the fact that the filaments were subject to superheating causing short life. Also, the human element materially entered into the operation of the equipment, permitting apparatus injury due to faulty operation. The operator was usually instructed to set the regulator at definite points per technique used. At 5 Milliamperes the heat of the filaments was low, and at high currents excessively high.

The variable voltage control arrangement for the filaments of valve tubes is not in keeping with the specifications governing most efficient valve tube operation. Practically all valve tube manufacturers domestic and foreign, recommend a definite setting of filament current which permits an abundance of free electrons in the tube, thereby lowering

the tube resistance and permitting efficient rectification with little voltage drop in the rectifying tube, a lack of heat on the target and, furthermore, a higher permissible current operation. It is only with 1000 Millampere Valve Tubes that the manufacturer recommends a higher filament heat than normal for high current operation and it is preferable to make this change with a positive throw over switch to give the exact rating automatically as recommended by the valve tube manufacturers.

With the foregoing in mind, the Kelley Koett Mfg. Company has adapted the voltage stabilizer to the rectifying circuit of valve tube apparatus. With this arrangement, the valve tubes are operated at the correct filament heat regardless of line voltage fluctuation or line drop when heavy currents are used. The maintained temperature of the filaments permits the valve tubes to operate at the point of greatest efficiency and least resistance.

A Power Stabilizer is connected in the filament circuit of the valve tubes, maintaining all filaments at a definite operating temperature of the exact specifications of the valve tube manufacturer. This constant temperature is maintained regardless of a 50% plus or minus voltage variation caused by any reason whatsoever.

The stabilized control of the valve tube filaments makes permissible the use of much higher current techniques with Keleket equipment than are available on conventional types. Furthermore, it is recommended that either sphere gap or spark gap be used for direct voltage calibration of the equipment as the short circuit load caused by sphere gap calibration will have no effect on the valve tube life or operating characteristics of the equipment.

The Stabilizing Unit functions so perfectly that it is actually possible to directly short circuit the high tension rectified current, placing the full output capacity of the transformer directly across the rectifying tubes and depressing the exposure switch time and time again with no effect on the tubes. The Stabilizing Unit maintains the filament current constant under this extremely heavy short circuit load operation and the adjustable circuit breaker opens the transformer line before any injury is done to the low tension circuit carrying parts.

From the foregoing, it can be readily appreciated that Valve Tube Rectified Apparatus presented by Keleket not only has all the advantages previously suggested with tube rectification, but none of the disadvantages presented by conventional types of equipment. In other words, it is a consummation of all the advantages of valve tube and mechanically rectified equipment with none of the disadvantages of either.

The Kelley Koett Mfg. Company, after due experimentation and deliberation, has placed on the market models of valve tube rectified equipment which are competitively non-comparable. With particular reference to the Radiographic Unit, the Kelley Koett Company does not make any claims of increased radiographic speed or increased contrast in negatives. Radiographic speed is primarily governed by high power factor transformer design rather than by rectification. The greater efficiency in the deep therapy equipment results from the use of high capacity condensers which act as storage units for the current, receiving impulsing direct current and delivering relatively uniform current to the X-ray tube.

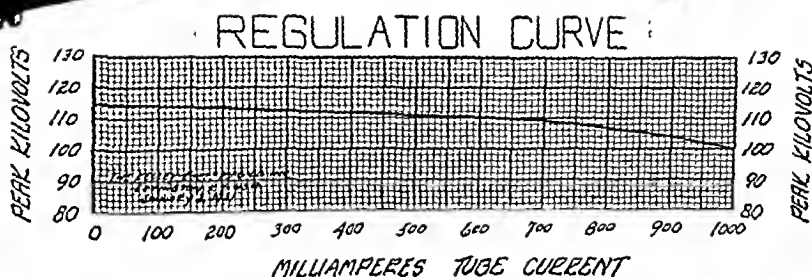
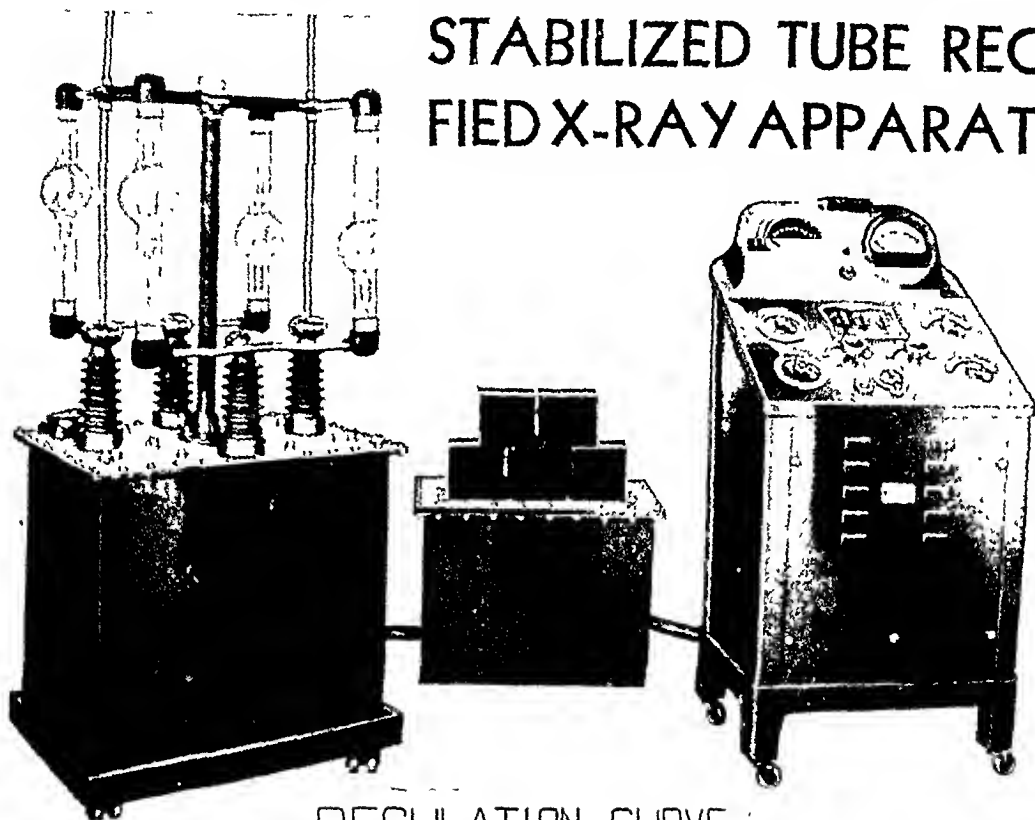
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## Third International Congress of Radiology

*Paris, July 26 to 31, 1931*

### Brief Preliminary Sketch of Official Pre-Convention Tour

LEAVE NEW YORK JULY 6TH, 10 P. M., STEAMER FRANCE, first class, arrive Havre July 14. Belgium, Holland, Hamburg, Berlin, Prague, Vienna, Switzerland, Genoa, Monaco, Marseilles, arriving Paris July 26, A. M. Paris in convention to July 31st.

Post convention tour to British Isles or Russia optional (details on request). Societies tour officially ends when convention ends, but every one furnished with ticket back to United States good on any French Line cabin steamer. No attempt is made here to give list of things we do in the above cities and countries except to say we cover everything of interest in the best manner. The ladies will be entertained while the doctors are at clinics.

THE PRICE INCLUDES one night at Hotel New Yorker or Hotel Lincoln (no meals) night before sailing, in New York City. Baggage insurance \$300 per person, covering loss, damage, pilferage, etc. Accident insurance \$10,000. (Common carrier.)

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Rooms at hotels and all meals (except dinners in Paris during convention). All admission to places visited. All handling of baggage. All taxis. One all night party Paris, to Folies Bergere, La Boheme, Le Perroquet, Zelli's, La Tour D'Argent, etc.. etc. On this party champagne is included (any quantity).

You have nothing whatever to do after you leave the hotel in New York except to go in one of our taxis to the ship. We perform complete courier service. Stops are one and two days, although account of Clinics more interesting in certain cities (for instance, Vienna or Berne) an additional day might be spent. Travel is by ocean liner, train, Rhine river steamer, taxi, DeLuxe autos and in one or two instances short trips are made by motor coach. Special trains if convention is complete 200 persons. All general tipping.

NOTE: The Doctors are leaving as an official party on the France, July 6th, taking the Continental tour and Clinics before the Paris convention because Clinic work is much more interesting in July than August (August being a standard vacation month for Physicians in Europe).

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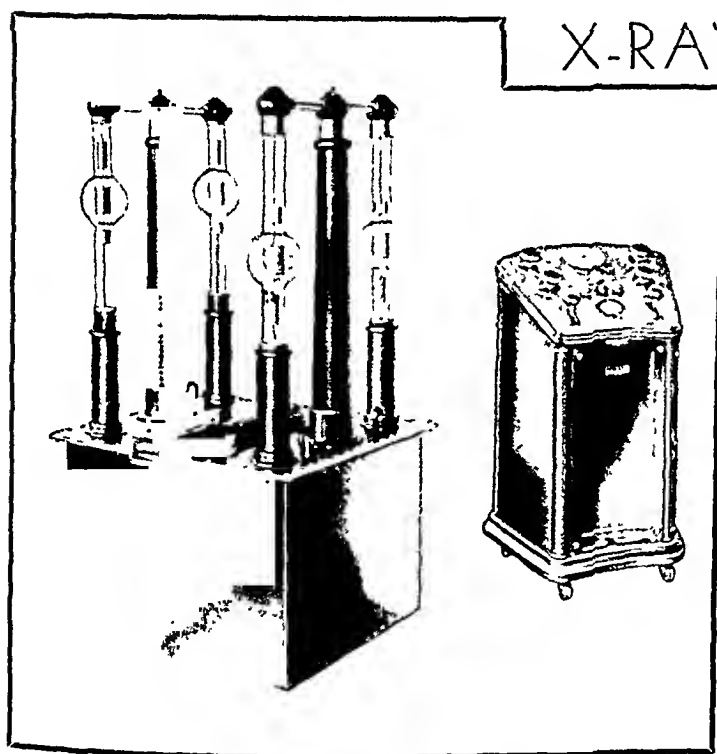
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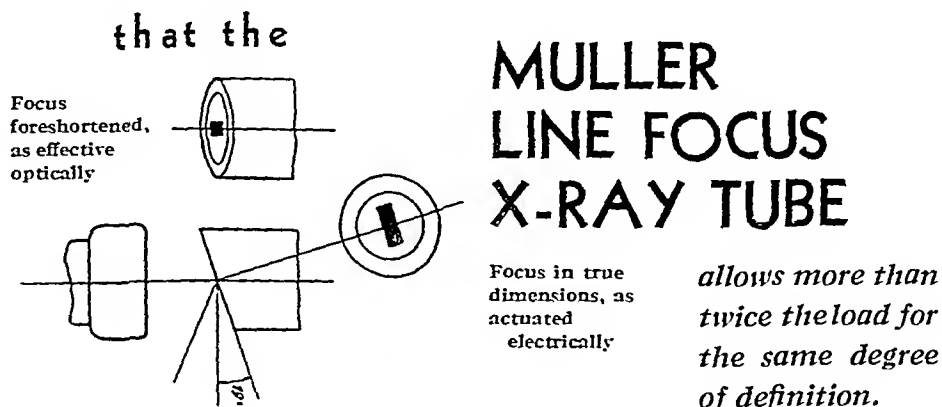
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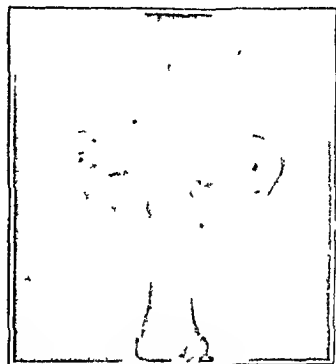


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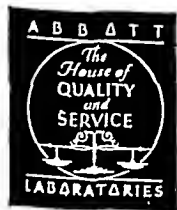
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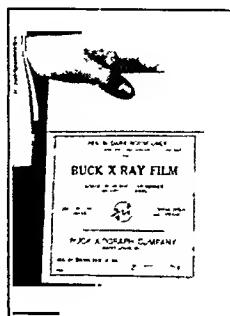
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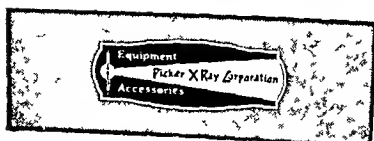
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A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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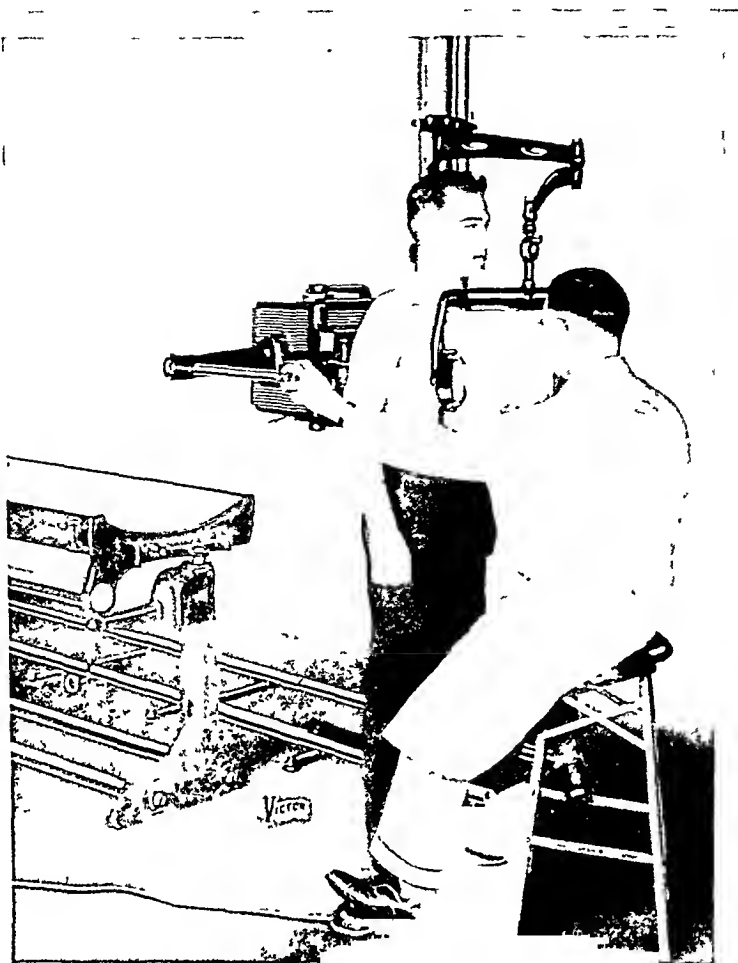
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## PALLIATIVE RADIOTHERAPY OF MALIGNANT GROWTHS<sup>1</sup>

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THE last few years have witnessed a remarkable change in attitude toward the problem of cancer therapy. The statistical study of the disease, with more careful death records and more autopsies, has shown that there has been in most countries like our own with defective death certificates, a large amount of unrecognized cancer. The statisticians feel that with the discovery of all this material, the cancer death rate will rise to something like 125 per 100,000, instead of the 95 per 100,000 which is now the official figure for the cancer rate in the United States. The propaganda of the American Society for the Control of Cancer has led to a demand from the public for more efficient therapy than the medical profession has been prepared to give, while studies of the records of hospitals have shown the relative inefficiency of cancer treatment when all types are included, only some 20 per cent of patients admitted to the hospitals being operable. Then the utterly unsupported claims for cures which followed the development shortly after the War of high-voltage X-ray apparatus caused the surgeons to study their own material with much more care, the results being a sudden sobering of the operative claims when cases were followed for periods of five years and more. Time has shown that neither the exaggerated statements of the

earlier roentgenologists were true, nor could the surgical statistics of twenty years ago be regarded as in any way representing the real results when patients were properly followed. What has arisen from the situation is, of course, the fact that surgery is still effective in certain groups of tumors and also that carcinoma of the cervix, especially the borderline groups, can be better treated by radiation than by surgery. The sobering attitude of all these facts is reflected in the changed attitude of the whole profession toward the actual cure of cancer, and the word "arrest" is now being used by those who try to make their language fit the facts. In some ways the surgical pessimism has gone a little too far, for a study of the material has revealed the disheartening fact that a patient cured of one tumor is perfectly capable of developing another one later,—a matter which should have been expected from the multiple occurrence of tumors in the same individual. In fact, recent studies have shown that this multiple occurrence is just what would be expected statistically from the frequency of cancer in the general population, that is, a certain number of patients might well develop two tumors, either simultaneously or within a short time of each other. It is, therefore, nothing astonishing that a woman cured of a carcinoma of the cervix may a few years later develop a carcinoma of the breast. Fortunately these double carcinomas are relatively rare.

<sup>1</sup>Read before the Radiological Society of North America at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1-5, 1930.

In the past, both surgeon and radiologist confined their attention to what they called "cures." The surgeon in such statements was on much sounder ground, for in a certain proportion of accessible malignancies he really did produce a cure. In my own records, and those of many other institutions, there are, for example, many cases of carcinoma of the breast which can be considered as cured in the true sense of the word, that is, they have gone eight to ten years without any evidence of return. True, recurrences have been seen after fifteen years or more in the regional nodes, lungs, or bones, but again, these are very infrequent. Only in carcinoma of the cervix and the skin are there any such long-time records of real cures from radiation. But if only 20 per cent of the hospital material is operable, what shall be done with the remaining 80 per cent? Many of these are entirely beyond any therapy. The results of radiation treatment of carcinoma of the lung, of the stomach, of the liver, pancreas, kidneys, prostate, and esophagus have in general been an utter failure when regarded from the point of view of permanent results, and in most of these sites—even from the palliative aspect, with but rare exceptions—nothing has been obtained. The operative achievements on carcinoma of the stomach, even in those cases which were considered operable, have been small. Carcinoma of the rectum has been somewhat more favorable in its surgical aspect because of the possibility of removing the gut completely and also because of the rather low grade malignancy from the surgical point of view of many of the neoplasms which attack this viscus. The same is true of certain other localities, when the patients come in the early stages for treatment. On the other hand, radiologically the rectum and sigmoid have been two of the least satisfactory, for the slow-growing mucus-forming tumors of this region, which are the most common type and metastasize late, and are therefore favorable to surgery,

have been so resistant to radiation that little palliation has been obtained.

Thus successful radiation implies an additional requirement not implicit for the surgical cure of a growth, that the neoplasm is radiosensitive. In some instances this is closely correlated with microscopic morphology, but one often meets with exceptions.

In the attempt to achieve the impossible by both surgery and radiation, extensive operative procedures, with a high resulting mortality, have been tried, but are now being abandoned. In the past, excessive radiation dosage, with serious damage to the patient's general health, has not been infrequent. But gradually the attempt to cure the incurable has been abandoned by both parties and a saner view prevails.

The destructive dose for tumors varies in man between 700 r-units and 7,000 r-units or more. The average is probably close to that of the transplanted animal tumors, which requires between 2,500 and 3,500 r-units for a complete destruction of all the cells. It is evident that human tumors of the higher degrees of radioresistance must be treated not only with external radiation through the skin, but an additional dose must be added by interstitial radiation with filtered radium, either element or emanation. Here the accessibility of the tumor to be treated plays as important a part as it does in surgical operability. Just as at least 80 per cent of those who apply for treatment for malignant tumors are already in an inoperable stage, so at least the same proportion are not in a condition suitable for the application of radiation for a cure.

If the patient is inoperable from the point of view of cure, and nothing can be promised from the radiation side, what may be done to prolong life within the limits of comfort or of ability to work? That is the point concerning which I wish to speak. Frankly confessing our inability to cure a certain group of tumors by any method, how far can we go with surgery, with radiation,

or with the combination of the two to prolong life in comfort? To be effective, such surgery must not be dangerous to the life of the patient, and the radiation must not be so heavy as to render the patients so miserable that they cannot go about their daily duties for a time. It is difficult to evaluate the results in statistical terms, for there is as yet but little accurate information on the length of life of the untreated patients, and nowadays there are relatively few patients who are never treated in some fashion. I have elsewhere made an appeal for the compulsory notification of all cases of cancer as soon as diagnosed, with the hope that the material so obtained might be used to give us further information on this important point, for it is easily seen that the mere collection of a series of patients with carcinoma of the rectum, for example, adding up the years and months that they survive, and dividing by the total, gives us no practical information. Unless it is possible to add to the crude survival periods some information concerning the histological types of tumor, their sites and distribution, the figures will be of but little value. Thus I have seen a patient with carcinoma of the rectum live seven years with a simple colostomy, but how many tables exist of a large series of patients treated with simple colostomy, with the microscopic examination of the tumor to correlate, if possible, the length of life with the histology? Until this is done we have no firm basis for assuming that radiation or surgery really does prolong life. All we can do is to study the individual and judge from his clinical course whether or not our therapeutic measures have been useful. And it must be frankly confessed that in not a small number of instances our best therapy fails to check the course of the disease, and the only thing which we can claim is that the patient's mental condition has been improved.

Take, for instance, the advanced, ulcerated carcinoma of the breast. What is the right thing to do for these unfortunate pa-

tients? Surgery offers no cure; neither does radiation. The nodes and thoracic wall are involved; mediastinal and bone invasion is probable. Nevertheless, in my own experience I have felt that the removal of the breast and as much skin as is possible without recourse to grafting, leaving the nodes in the axillary and supraclavicular regions undisturbed, does help these patients. With our present operative technic the mortality is extremely low. The anesthesia is not dangerous; the operation can be done in a relatively short time, and the patient can leave the hospital in ten days or two weeks. The mental horror which accompanies these huge ulcerating masses is relieved. The patient no longer is an offense from the odor which follows the invasion of putrefactive organisms into the necrotic material. Dressings are no longer needed, and the patient is relieved of that expense. As soon as the wound is healed post-operative radiation with moderate voltages should be given over the nodes of the neck, the axilla, and the entire skin surface in which invasion may be expected. If the patient begins to cough, high voltage doses should be directed to the mediastinum. X-ray films will often reveal nodules in the chest to which attention can be directly paid during the course of the radiation. The cough, of course, is due to the pressure on the bronchi and trachea, with consequent narrowing of the lumen, retention of secretion, or irritation from invasion of the bronchial wall. Many of these patients can have their cough relieved for considerable periods. The accumulation of pleural exudate also is checked. If the bones are involved, they can be radiated, with the relief of pain. In most patients of this type no local skin recurrence will follow if sufficient radiation is given. This means treating these persons every week or two for some time over the suspected areas. In my own material a number of these patients have been able to go back to work and be fairly comfortable for varying periods of from six

months to four years. If the tumor metastasizes in the bone it usually does not seem to involve the lung, and the reverse is true. The bone cases are the most suitable for the prolongation of life. They can be rendered

dence is pretty clear that she had early bone involvement, because she noticed a pain in the right femur January 7, 1925, and X-ray films (Fig. 1) taken at that time showed extensive metastases into the right femur and

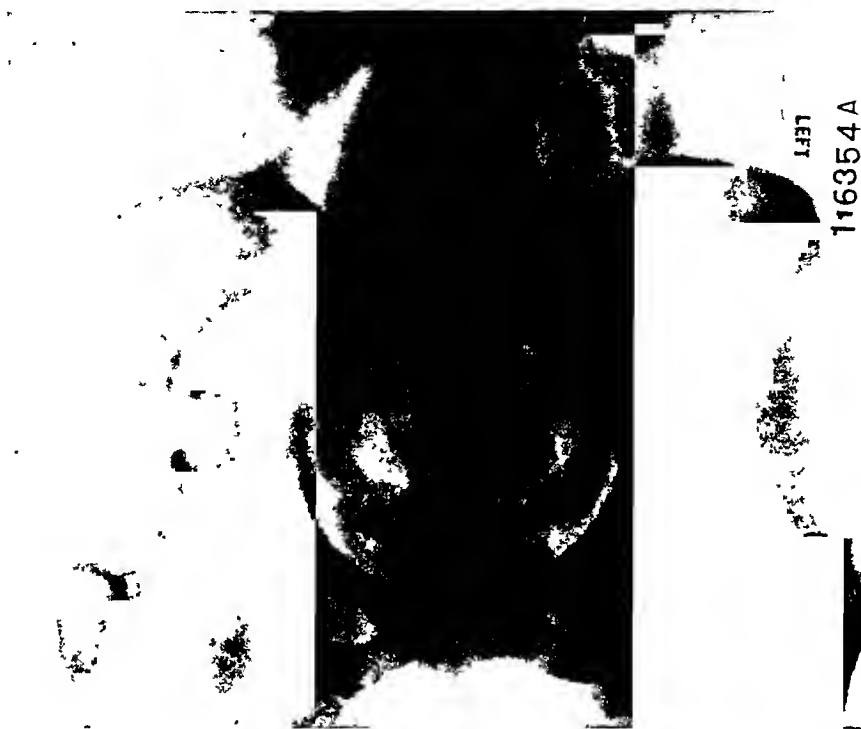


Fig. 1. Lesion found March 17, 1925, showing extensive erosion of the pelvic bones.

very comfortable by moderate radiation, whereas the lung cases as a rule go rapidly, but if sufficient radiation is given, the cough can be kept down, as has already been said, and when the fatal termination comes, it is usually rapid. They often develop a low grade pneumonia and die in a few days. A number of my patients with bone involvement have developed cerebral metastases, with death in a very short period, though they have been perfectly comfortable up to the occurrence of this accident.

The following is an example of such palliation. The patient, a woman of 48, came to my clinic on crutches on February 1, 1925. She had had an amputation of the breast in May, 1924. The growth was evidently a fairly extensive one, and the evi-

lium. Radiation was immediately begun over the pelvis, 160 K.V., 0.5 mm. zinc plus 1 mm. aluminum filters, 40 cm. distance, giving about 80 per cent of an erythema. The treatments were given, as usual, about two weeks apart. She had no improvement for two months, but on March 30 she reported that she had no pain, and that she could lie on the right side. Crutches were abandoned, and she was taking no sedative medicine. She was doing her housework, and was gaining weight. In 1928 she complained of pain in the right shoulder, and X-ray examination showed involvement of the scapula, clavicle, and the upper end of the humerus on the left side (Fig. 3), and there was some evidence of involvement of the ribs on the right. Radiation of these areas checked

her pain. On May 1, 1928, she fell and broke her radius, which healed promptly. There was no evidence that this was a pathologic fracture. From time to time the pelvic condition was radiated, and there seemed

back to her work and live in fair comfort, gaining weight, and feeling well for three years and four months, when she died suddenly from a cerebral lesion. My records show a number of similar palliations, some



Fig. 2. Roentgenogram made February 17, 1927, showing repair in bones of the pelvis. Same case as shown in Figure 1.

to be a certain amount of ossification taking place in the old areas, which were almost free of bone, as the cuts will show (Fig. 2). During 1928 she was radiated chiefly to the shoulder—the pelvis and the hip gave her no pain. On May 11 she came in and reported that she had a little pain in the right ear, but otherwise was very well. She died suddenly on June 6, 1928, with a cerebral involvement, having been sick only a few days.

This was a case of a woman palliated for over three years. Her condition was so bad that she was walking on crutches and taking a considerable amount of narcotics. After a few radiation exposures she was able to go

longer, some shorter, including one with a moderate paraplegia who for a year after treatment was able to walk without support.

Another example of prolonged palliation is a case of carcinoma of the breast. This woman was admitted to my clinic on July 21, 1925, the referring surgeon saying that she had an extensive carcinoma, with much involvement of the axillary nodes, and that she should have heavy radiation, if possible. Treatment was begun with our usual technic of about 75 to 80 per cent of an erythema dose, at 160 K.V., 0.5 mm. zinc and 1 mm. aluminum filters. During 1926 the patient was very well and gained in weight. In July, 1927, she was reported as all right, and had



Fig. 3. The shoulder lesion on February 2, 1928. Same case as shown in Figures 1 and 2.

gained several pounds. In 1928 she began to cough, but there was no radiological evidence of recurrence. Shortly after this she was told by a physician that she had a carcinoma involving the entire lung. An X-ray film taken on February 3, 1930, showed that the patient's lung condition had greatly improved since the radiographs of September, 1929, and films taken on September 16, 1930, again reported some improvement in the lung condition. Despite the lung involvement in 1929 the patient gained weight under renewed radiation, and reported on January 3 that she had gained 12 pounds in the last three or four months. She was, however, short of breath. Radiation was changed from the lower voltage to 200 K.V., 8 ma., 50 cm. distance, and 60 minutes exposure with 0.5 mm. copper and 1 mm. aluminum filters. This is about 600 r-units. Under this treatment she continued to improve. At her last appearance, November 11, 1930, she was so short of breath that she was advised not to take any more treatments.

This is a record of an extremely advanced, hopeless case of carcinoma which survived in fair comfort a little less than five years.

An example of an unexpected palliation of a sarcoma of the pelvis follows. The patient was a woman 43 years of age, who had had pain in her left hip for several months. On examination there was found to be a large palpable mass which involved the inner surface of the left ilium. The iliac muscle was pushed up over the tumor. Radiographs showed no attachment to the bone. Biopsy revealed a tumor composed of small cells with no bone formation. She came under my care on March 31, 1925. After two exposures the patient reported her pain was much diminished. She was radiated fifteen times during 1925, the doses being about 80 per cent of an erythema, 160 K.V., 0.5 mm. zinc and 1 mm. aluminum, 40 cm. distance, and 8 milliamperes. During 1926 she received thirteen treatments; in 1927, eight treatments, and in 1928, seven treatments. On March 25, 1929, the patient said that she had never felt so well. During all this period she had been at work, and had gained 22 pounds in 1926. In December, 1927, she was examined by the surgeon in whose care she had originally been, and he reported that she was in fine condition. The patient was last seen by me on May 21, 1929, when she repeated the above statement about feeling so well. She was told to come back in the Autumn, but failed to keep her appointment. On inquiry by a social service nurse it was found that she had died very suddenly on June 29, whereas on May 21 she had felt extremely well. No explanation could be obtained for this death. It might have been a cerebral metastasis or any one of the complications which may occur in conjunction with malignant growths, but there was certainly no local return.

An example of prolonged palliation in a case of carcinoma of the breast is the fol-

lowing. A woman 48 years of age was referred to me for treatment for a large fibromyoma of the uterus reaching the fundus. As she had high blood pressure and headache, it was thought wiser not to operate on her. She received eight X-ray treatments, at 160 K.V., with 0.5 mm. zinc and 1 mm. aluminum, 40 cm. distance, 8 ma., and 15 to 20 minutes. This checked her periods; the myoma shrank down, and her pressure symptoms were entirely relieved. About the time this treatment was finished, some two months after she came to me, she called attention to her breast, and I found that she had a carcinoma with axillary nodes. She was operated on promptly. She developed a recurrence in the pectoral region, above the level of the axilla, six months later, and when seen by her surgeon, he regarded her as inoperable. There were also some enlarged nodes in the supraclavicular region. A roentgenogram at this time showed there were no definite areas of infiltration in the lung, but evidence of considerable pleural thickening at the site of the swelling. At this time she consulted Dr. Burton Lee of the Memorial Hospital, in New York, who advised the radium pack, insertion of gold needles in the nodule in the anterior axillary region, and treatment of the mass in the other axilla by the insertion of platinum needles. This the patient refused, preferring to take X-ray treatment. Exposures were then given of the same type as mentioned above, but somewhat heavier, reaching about 90 per cent of an erythema dose—at one time she did receive an erythema. These were repeated about every two weeks with intervals of rest, and in 1926, a year after the first operation, she had marked edema, with distinct nodes above the left clavicle, and the left arm began to swell. Radiation was continued, and in June, 1927, I had a note saying that she was in fine condition. There was some slight swelling of the left arm; the mass in the pectoral region had disappeared, as well as the nodes. The nodes

above the clavicle were not palpable. The mass in the right axilla had disappeared entirely under radiation of that region. Following January 21, 1928, that is, three years after her operation, she showed no evidence of carcinoma. On November 20, 1930, she had no evidence of any trouble except the swelling of the left arm, with a good deal of puffiness above the left clavicle. The nodes in that region could not be definitely made out. There was nothing to feel in the right axilla.

Here is a patient who was seen by three surgeons, all of whom believed she had a recurrence, and yet that recurrence disappeared under radiation of a very moderate voltage and quantity, and the patient was apparently in perfect health five years after her operation.

A highly sensitive tumor may disappear with very little radiation. A patient, male, 34 years of age, was referred to me by a surgeon on account of a very large abdominal tumor, the size of a pregnancy about the eighth month. The patient reported that his left breast had been very much swollen a year before, but under local treatment this swelling disappeared in two weeks. After this he noticed the abdominal tumor. At the time of examination this tumor filled the whole abdomen, was smooth, elastic, and not very firm. On physical examination the left testicle was found to be missing, and the patient stated that the tumor had begun on the left side. The man was rather pale, but otherwise nothing was found on physical examination. Biopsy was refused, but the growth was probably a seminoma. The patient received three heavy doses of X-ray, one on the right side of the abdomen, one on the left, and one on the left hip. These were just sub-erythemas. Two were given at 160 K.V., with 0.5 mm. zinc and 1 mm. aluminum filters, and one at 200 K.V., with 0.5 mm. copper and 1 mm. aluminum filters. Within a short time after these treatments, the tumor disappeared. A month after the



man was first seen he had gained three pounds; two months later he had gained six and a half pounds more. After this, at monthly intervals, the patient received moderate doses of X-ray at 190 K.V., with 0.5 mm. copper filter. The doses were about 80 per cent of an erythema, and were given with the idea of preventing the possible return of the tumor. We heard from him last on February 24, 1930, that is, five years after his first treatment, and he reported that he was in perfect health. The value of the report suffers from the fact that no biopsy was done, as the tumor was so large that the competent surgeon who saw him first thought he was not justified in doing a laparotomy merely to get a specimen. Presumably the growth was a seminoma of the testicle, which is known to be highly sensitive to radiation. The point is that at no time was this man given extremely heavy doses, except the first three treatments, after which the tumor disappeared.

Another interesting case is that of a female child 21 months old. The patient was explored in December, 1924, because of an enormous tumor which filled the whole abdomen. The tumor was found to be inoperable, and unfortunately the surgeon took no biopsy, considering the child's condition to be too desperate to take any risks of prolonging the operation. The growth was probably a neuroblastoma, as such growths are sensitive. At this time there was moderate paraplegia, apparently due to pressure from the tumor. Radiation was begun, about 300 r-units, at 200 K.V., with 0.5 mm. copper and 1 mm. aluminum, on January 13, 1925, and repeated at intervals of about two weeks. The child began to show distinct improvement five months after the first radiation. For three months no treatment was given, and then it was begun again and carried on at about monthly intervals, the doses being about 400 r-units. During the following year fourteen treatments were given. The year after that, eight; the

next year, six; the next year, only three, and this year, only two. A year after the treatment was begun the child was much better, and the tumor was smaller. Eight months later she was reported as very well. Nine months later the tumor mass began to grow, and radiation was given more frequently. On May 22, 1928, that is, two years and four months after the treatment was begun, there is a note that the child was in fair condition and the mass smaller than at first. On November 26, 1928, the records say the child was in good shape, the mass was smaller, and the condition excellent. On February 18, 1930, came a note saying the child was in good condition. I saw her on November 18, 1930. No tumor mass was palpable. The child looks like a normal child of six years of age, bright and intelligent. Incidentally, she walks perfectly at the present time.

Another example of palliation in a radio-sensitive tumor was a male 46 years of age, who had a large retroperitoneal lymphosarcoma, the diagnosis having been made by biopsy. He was referred to me on October 13, 1925. Treatment was begun with moderate voltage X-ray, about 160 K.V., 0.5 mm. zinc and 1 mm. aluminum, giving about 400 r-units per dose, and using various portals to radiate the large mass in the abdomen. The treatments were given at about two-week intervals at first, and then less frequently. In 1927 he received only five treatments, and in 1928 only two. In 1929 he was examined by the surgeon who referred him to me, and was found to have no evidence of any trouble. On September 25, 1930, that is, about five years after his first treatment, he reported that he had been entirely well until about three weeks before, when he had become short of breath and weak. Examination showed the spleen to be very much enlarged, but there were no other nodules. The patient is still under treatment, but it is evident that return of the growth has begun. Nevertheless, here is

a five-year palliation with moderate X-ray dosage.

I feel very strongly from the study of individual patients, though I cannot demonstrate from a large amount of material, that this technic of handling advanced and hopeless mammary carcinoma, even though it does not necessarily prolong life, brings a great deal of comfort to the patient. How difficult it is to judge these matters is well illustrated by the treatment of myelogenous leukemia. A number of writers have stated that radiation does not prolong the average life of these patients. Nevertheless, I have a number of patients with leukemia, who, when I first saw them, were moribund, either because they had been treated improperly or because a diagnosis had never been made. Some of these patients had a hemorrhagic condition with large nodules in the skin and an enormous number of leukocytes—sometimes up to a million, with great destruction of the red cells. In a month or two they were back at work, the spleen reduced to almost normal dimensions, the hemorrhagic diathesis stopped, and they have remained in this condition for three or four years. Now certainly these patients would have died within a few weeks if not treated, so that I cannot agree with those who say that life is not prolonged. It may be that in a large series no great average prolongation of life is observed, but the individual case may show a remarkable capacity to come back. The physician does not refuse to treat cardiac and nephritic patients, even though he cannot cure the lesion. The main thing is to get the patients adapted to the physical limitations which the disease imposes on them and make them useful within these limits, even though the lesion may remain unchanged so far as anatomical conditions go.

In addition to the purely scientific aspect of all this material, the economic question of radiation plays a fairly important part. Inasmuch as the average income of a citi-

zen of the United States is somewhat under \$2,000 a year, it is obvious that the average cancer patient cannot afford high-priced treatments, so we must make every effort to render such radiation reasonable in price. This implies a large amount of material, handled in an efficient and business-like way, so as to reduce overhead costs as much as possible. From the cases cited you will see that many of them have been treated with low voltages, not above 160 kilovolts. Under these conditions even the inefficient X-ray tubes which we now possess for therapeutic purposes last six months or more if used eight hours a day. The tube cost per patient is therefore low. Experimental tubes have been made which have four or five times this life, and the Radiological Society should make every effort to see that these tubes come on the market as quickly as possible.

On the other hand, there is a certain amount of physical and clinical evidence which points to the necessity for a change in the type of our radiation if the best results are to be obtained. The biological experiments which Regaud made many years ago have not excited very much interest in this country. These furnished the demonstration that sterilization doses, using the testicle as biological material, are most efficient when they are given as a divided dose on successive days rather than as the single huge exposure originally recommended by German workers. In addition, Regaud showed that the use of highly filtered X-ray given for long periods was more effective than shorter doses. The combination of these principles is seen in the current practice at the Curie Institute, where carcinomas of the oral cavity are treated with exposures of four or five hours a day for from ten days to two weeks, giving a total of 7,000 or 8,000 r-units. Under these conditions a severe erythema is produced, but it does not as a rule go to blistering, the lesion heals quickly, the skin remains soft, and the vas-

# ABSORPTION MEASUREMENTS OF THE X-RAY GENERAL RADIATION<sup>1</sup>

By LAURISTON S. TAYLOR, WASHINGTON, D. C.

*Abstract.*—Studied as a means for indicating the quality of the radiation, copper absorption curves for heterogeneous X-rays were obtained, using a standard and two thimble ionization chambers. With the standard air chamber, logarithmic absorption curves were not found to become straight for filters up to 3 mm. in thickness—indicating a gradual elimination of the longer wave lengths. With thimble chambers, owing presumably to errors from the chamber “wall effect,” the curves were non-linear only up to 1 mm. thickness of filter.

Half value layers and effective wave lengths derived from the three sets of results were compared. The “effective wave length” as

derived from the slope of the absorption curve and the “half value layer” are about equally sensitive to changes in quality, at least up to 3 mm. thickness of filter. As should be expected, effective wave lengths thus obtained are always longer than those obtained by Duane’s finite filter method and, being less dependent upon the particular instrument used in the measurements, are, therefore, more consistent.

On the basis of the effective wave length determinations it is found that, contrary to the accepted views, the greater part of the highly filtered energy is not concentrated in the tungsten K lines.

## I. INTRODUCTION

IN connection with the proper control of X-radiation in its various applications, reliable and relatively convenient means of measuring the radiant energy is the first necessity. This part of the problem seems to be satisfactorily solved by observing proper care in the design and use of the ionization chamber. The Bureau has, therefore, announced its completion of a standard ionization chamber.<sup>2</sup> The next project on this program is the study of possible methods of determining “quality” of radiation. The accuracy with which it is necessary to describe the quality depends, of course, upon the particular use to which the radiation is put. In radiological practice an accuracy of 3 to 4 per cent may be sufficient, whereas in precise physical experiments the accuracy should be better, as indicated, for example, in the recent papers by Compton,<sup>3</sup> and Crowther and Bond.<sup>4</sup>

In the radiological field recent work by Pohle and Barnes,<sup>5</sup> Quimby,<sup>6</sup> and Burby and Barry<sup>7</sup> has shown large discrepancies in the qualities of the different X-ray beams as measured by different methods. Moreover, Quimby showed that three beams having the same “quality,” according to some Method A, had radically different “qualities” according to another Method B. It thus appeared desirable to make a fairly comprehensive study of available methods and the devices used in applying them.

Inasmuch as a beam of X-rays may cover a range of wave lengths which are unequally effective in producing the results sought, next in importance to measuring the total energy is that of determining the distribution of the energy among the wave lengths present. A direct measurement of spectral energy distribution is the most reliable and satisfactory way of describing the quality of the radiation, but this is so difficult and cumbersome that the method eliminates itself from the field of practical applications.

<sup>1</sup>Reprinted from Bureau of Standards Journal of Research. Research Paper No. 212, September, 1930.

<sup>2</sup>Radiology, April, 1930, XIV, 416. Am. Jour. Roentgenol. and Rad. Ther., 1930, XXIII, 316.

<sup>3</sup>A. H. Compton, Phil. Mag., 1929, VIII, 931.

<sup>4</sup>J. C. Crowther and W. N. Bond, Phil. Mag., 1928, VI, 401.

<sup>5</sup>E. A. Pohle and J. M. Barnes, RADIOLOGY, 1928, X, 300.

<sup>6</sup>E. H. Quimby, Am. Jour. Roentgenol. and Rad. Ther., 1929, XXI, 275.

<sup>7</sup>J. J. Burby and M. W. Barry, RADIOLOGY, 1929, XII, 275.

Fairly sound substitute methods of greater utility have been based on the degree of absorption of the total energy by filters of standard materials (copper, silver, alumi-

In using such data to determine minimum wave length,<sup>8</sup> it is necessary to extrapolate the curves to zero energy by starting at some point well up on the established curve,

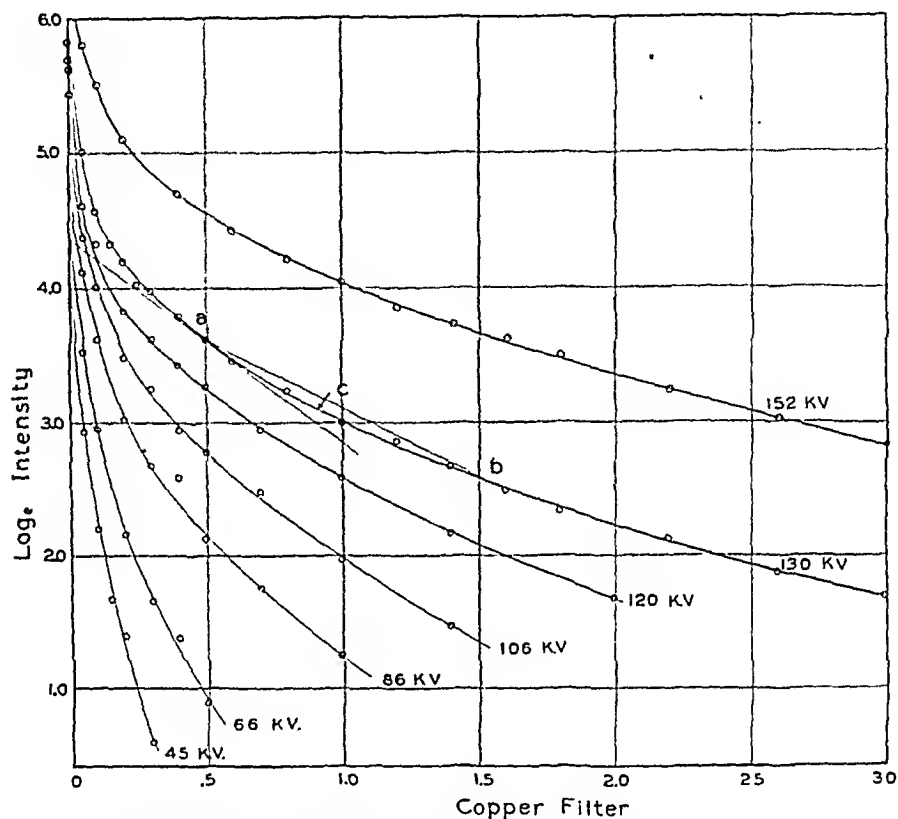


Fig. 1. Copper absorption curves made with standard air ionization chamber for practically constant voltage X-rays.

num, etc.), knowledge of the incident radiation being inferred from the absorption measurements of various filter thicknesses.

Even if the ionization spectrometer method of mapping the spectral radiation were not so difficult and cumbersome under present conditions, it would still be far from an ideal method owing to the many conditions involved, some of which are not well understood. The more common forms of the X-ray spectrograph as substitute for the ionization spectrometer are inadequate, for, due to such factors as X-ray scattering, photographic halation and spectral sensitivity of the emulsion, a simple density curve of the photographic plate may be very misleading.

which, of course, makes for very uncertain conclusions.

With these facts in mind the best method, for practical purposes, for arriving at the quality of any given X-ray beam seems to be that involving direct absorption measurements.

In deep therapy wave length ranges, Duane has shown that absorption measurements in copper are well suited for describing the quality.<sup>9</sup> In the superficial therapy range, either copper or aluminum absorption measurements<sup>10</sup> may be used; and, in

<sup>8</sup>A. Mutscheller, *RADIOLOGY*, 1929, XII, 283.

<sup>9</sup>William Duane, *Am. Jour. Roentgenol.*, 1922, IX, 167.

<sup>10</sup>William Duane, *Am. Jour. Roentgenol. and Rad. Ther.*, 1928, XX, 241.

The effective wave length as defined by Duane<sup>23</sup> is "the wave length of monochromatic radiation that would produce the same effect (readings of the instruments employed, etc.) that the actual radiation produces." His method of measurement con-

ly above and below the filter for which the radiation quality is desired. The absorption coefficient and corresponding  $\lambda_e$  is then obtained from the difference of the logarithms of these two intensity measurements, it being assumed that this absorption coefficient

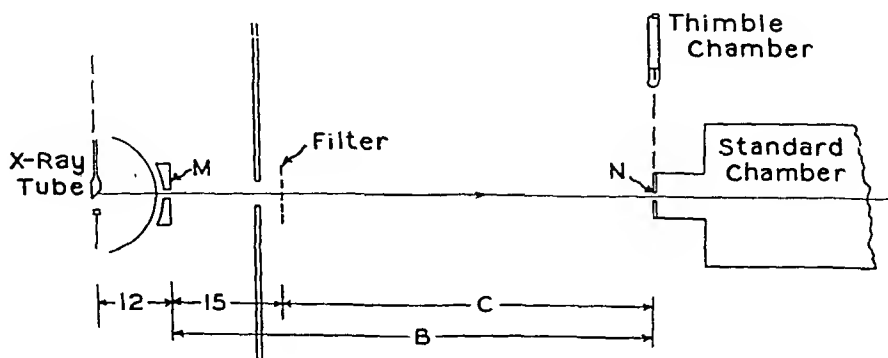


Fig. 2. Diagram of X-ray tube-filter-ionization chamber system.

sists in determining the percentage transmission of the given filter for the given radiation, then determining  $\lambda_e$  from previously constructed calibration curves, as obtained from the absorption law indicated in Equations (2) and (3).

The so-called "true effective wave length" is independent of any given filter thickness; and, in that one other factor is thus eliminated from its determination, it is physically a more desirable way to express the quantity sought. For its determination, a logarithmic absorption curve is established with a series of filters of increasing thickness and the slope at the point in question gives directly the composite absorption coefficient  $\mu$ . From monochromatic wave length absorption curves or Richtmyer's formula (Equation (3a)) may thus be determined, as the true effective wave length  $\lambda_e$ , the single wave length which has the same absorption coefficient.

A "bracket" method for obtaining  $\lambda_e$  may also be used wherein two intensity measurements are made for filter thicknesses equal-

is the same as that corresponding to the intermediate filter. Such a method, while nearer the tangent method (true  $\lambda_e$ ) than Duane's, does not make full allowance for the curvature of the logarithmic absorption curve between the points taken.

The bracket method is exactly the same as Duane's method as far as the operational procedure is concerned, except that the radiation for which  $\lambda_e$  is determined corresponds more nearly to that of the intermediate filtration instead of the smaller filtration. By Duane's method the ratio of the two intensities  $(E')/(E'')$  for filtrations  $x'$  and  $x''$  is said to give  $\lambda_e$  for the filtration  $x'$  whereas the bracket method gives  $\lambda_e$  for a filtration close to  $(x' + x'')/2$ . As shown later, the difference between the two varies according to the range in which the measurements are applied, and may be neglected for many practical purposes.

In Duane's earlier work he specified the use of 1 mm. of copper for obtaining the effective wave length. The use of such a large filter-difference will give reasonably consistent agreement with the true  $\lambda_e$  only

<sup>23</sup>William Duane, Am. Jour. Roentgenol. and Rad. Ther., 1928, XX, 241.

for very high filtrations as shown in Table II and when used according to the bracket method (Equation (8)). For lower filtrations the differences between the two methods increases. In later work he specified the use of 0.25 mm. filter separation, thus in-

heterogeneous X-ray beam was to measure the absorption by a series of filters of some material and then determine from the absorption curve the thickness of that material which would reduce the intensity of the given beam to one-half its initial value. If,

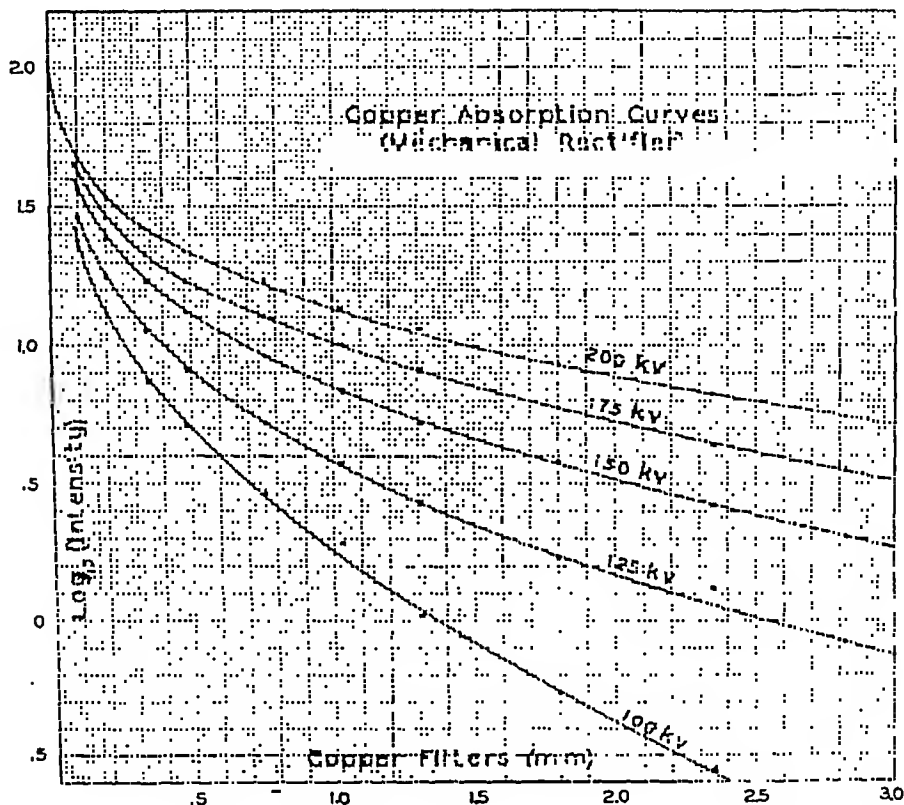


Fig. 3. Copper absorption curves made for mechanically rectified voltage.

creasing considerably the range over which  $\lambda_e$  might be determined with fair agreement with the other method (true  $\lambda_e$ ).

Duane also indicated at the time that small errors in the measurement of filter thickness may cause an appreciable error in the determination of  $\lambda_e$  by his method. The effect on  $\lambda_e$  of errors in thickness will, of course, be greater for the method using 0.25 mm. filter separation than for the 1 mm. method. In the case of obtaining  $\lambda_e$  from a complete absorption curve such errors are averaged out.

(B) *Half Value Layer*.—One of the earliest methods of describing the quality of a

for example, a beam has an intensity of  $E_{F1}$  after passing through a filter of thickness  $x_1$ , and  $E_{F2}$  is the half-intensity ( $E_{F1}/2$ ) after passing through a filter  $x_1 + x_2$ , then  $x_2$  is the half value layer of the particular material for that radiation which has passed through  $x_1$ . While then the quality is expressed by the effective wave length as determined by a given thickness of filter of given material, the half value method expresses the quality in terms of the thickness of filter (of given material) required to reduce the intensity by a given amount (one-half).

Obviously, the shorter the effective wave

length of the given radiation, the thicker this half value layer of filtering material must be. Inasmuch, therefore, as the composite absorption coefficient  $\mu$  of Equation (4) varies with the thickness  $x$  of the added filter, there is no simple direct quantitative relation connecting effective wave length with half value layer.

Comparing the half value layer and effective wave length method, the latter has the advantage in that it presents a clearer physical picture of the radiation quality.

In roentgenological practice, the voltage wave forms are usually of two general types, being either approximately constant or approximating a sine wave; and the target material is always tungsten. Here the half value method has served as a useful approximation for expressing the radiation quality. However, as a particular example, it is unsafe to rely on this method for comparing qualities of two radiations, one excited by constant and the other by a fluctuating voltage. Quimby<sup>24</sup> made a detailed study of the qualities of various radiations, all having the same half value layer of copper, and found large differences among them.

The inset (A) in Figure 5 shows a plot of the half value layer taken from the absorption curve in Figure 5, for filtrations as high as 1.6 mm. of copper. Investigations cited<sup>25</sup> have indicated that such a curve would be different for each voltage wave form applied to the tube.

(C) *Average Wave Length*.—This method was proposed by Mutscheller<sup>26</sup> several years ago. It follows the true effective wave length method in that from the tangent to a heterogeneous radiation absorption curve a coefficient of absorption is determined from Richtmyer's tables with which the corresponding monochromatic wave length is identified. He definitely divides his meas-

urements into two classes, those for the portion of the absorption curve from zero to the "homogeneity filter"<sup>27</sup> and those beyond this point.

According to the results presented in this paper there can be no "homogeneity filter," strictly speaking. Practically a filtration may be reached beyond which the radiation quality changes comparatively little—the absorption curve approaching linearity.

In most of his published absorption curves he shows such linearity above about 0.5 mm. copper filtration, indicating the attainment of effectively homogeneous radiation. There is no evidence that such a condition should be rigidly true and it is not reached within the range of filtration (0 to 3 mm. Cu) used in this paper. It appears, therefore, that the average wave lengths so obtained in the region beyond the "homogeneity filter" are subject to errors larger than herein contained; that is, Mutscheller's method is that of the true effective wave length above but applied in the range where the errors are such as to render the results questionable. Applied in the region below the "homogeneity filter"—that is, for small filtrations—his method is identical with the so-called true effective wave length method.

### III. EXPERIMENTAL RESULTS

#### 1. *Comparison of Different Ionization Chambers*

In the development thus far we have dealt with ideal conditions wherein it has been considered possible to make direct energy measurements. However, in applying absorption measurements as an indication of the quality of a given X-ray beam, the ionization current produced by the beam is the quantity measured. The current per unit energy does not change rapidly with wave length, and for simplicity we will speak of this as energy, understanding, of course, that the measured ionization is pro-

<sup>24</sup>E. H. Quimby, *Am. Jour. Roentgenol. and Rad. Ther.*, 1927, XXI, 64.

<sup>25</sup>See Footnotes 5, 6, 7, and 29.

<sup>26</sup>A. Mutscheller, *RADIOLOGY*, May, 1924; October, 1924; April, 1924.

<sup>27</sup>E. A. Pohle, *RADIOLOGY*, 1928, X, 300.

portional to the energy absorbed from the beam by the air in the ionization chamber.

The results of absorption measurements made by a number of observers are not in close agreement; consequently the technic

erated at practically constant potential, as recently described. The diaphragming system<sup>29</sup> to limit the beam was in accordance with the necessary conditions to make an accurate determination of the effective in-

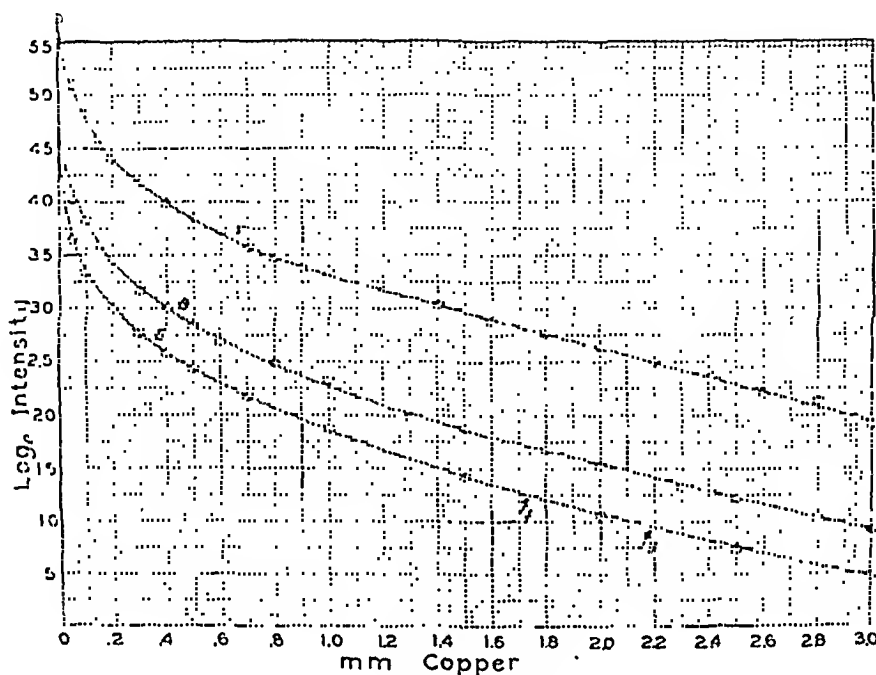


Fig. 4. Copper absorption curves made for 133 K.V. radiation, using three different chambers.

of making such measurements has been studied in the greater detail given here.

In some recent work at this laboratory a study was made of the calibration of the thimble ionization chambers against a standard air ionization chamber<sup>28</sup> in which it was brought out that there was a marked difference in the copper absorption curves for the same radiation when measured with several different thimble ionization chambers and the standard chamber.

In Figure 1 is shown a series of semilogarithmic copper absorption curves obtained by measuring the incident and transmitted intensities with the standard air ionization chamber. The tungsten X-ray tube was op-

tensity of the beam in roentgens.<sup>30</sup> When a thimble ionization chamber was used, it also was in accordance with previously described technic.<sup>31, 32</sup> The configuration of the system in Figure 2 shows the arrangement diagrammatically, and is self-explanatory.

For the curves shown in Figure 1 the diaphragms *M* and *N* each had a radius of 12 mm. and the interdiaphragm distance *B* was 65 centimeters. The filters were 15 cm. from *M*, thus making the distance *C* between filter and chamber diaphragm 50 centimeters. In taking these data the precision of observation for a single filter was about  $\pm 0.2$  per cent. The copper filters had a

<sup>28</sup>L. S. Taylor and G. Singer, Bureau of Standards Jour. of Research, 1930, IV (R. P. 169), 631.

<sup>29</sup>L. S. Taylor, Bureau of Standards Jour. of Research, 1929, II (R. P. 56), 771.

<sup>30</sup>L. S. Taylor, Bureau of Standards Jour. of Research, 1929, R. P. 119, p. 807.

<sup>31</sup>See Footnote 28.

<sup>32</sup>L. S. Taylor, RADIOLOGY, 1930, XIV, 551.



TABLE I

| Filter | Standard |              | Friedrich |              | Glasser |              |
|--------|----------|--------------|-----------|--------------|---------|--------------|
|        | $I_s$    | $\log_e I_s$ | $I_f$     | $\log_e I_f$ | $I_a$   | $\log_e I_a$ |
| (1)    | (2)      | (3)          | (4)       | (5)          | (6)     | (7)          |
| 0      | 100.0    | 4.60         | 312.0     | 5.74         | 111.0   | 4.71         |
| .05    | 38.4     | 3.65         | 164.0     | 5.10         | 55.7    | 4.01         |
| .1     | 28.6     | 3.355        | 123.0     | 4.81         | 45.4    | 3.82         |
| .15    |          |              | 99.0      | 4.58         | 35.7    | 3.58         |
| .2     | 20.0     | 3.00         | 81.6      | 4.40         | 30.4    | 3.46         |
| .25    | (17.8)   |              | 72.6      | 4.285        | (26.8)  |              |
| .3     | 16.1     | 2.78         | 66.3      | 4.194        | 23.8    | 3.16         |
| .4     | 13.0     | 2.56         | 53.6      | 3.98         | 20.0    | 3.00         |
| .5     | 11.5     | 2.44         | 48.1      | 3.87         | 17.2    | 2.84         |
| .6     |          |              | 41.2      | 3.72         | 14.8    | 2.69         |
| .7     | 8.70     | 2.16         | 35.6      | 3.57         | (13.4)  |              |
| .8     |          |              | 32.5      | 3.48         | 12.1    | 2.495        |
| .9     |          |              | 29.8      | 3.39         |         |              |
| 1.0    | 6.49     | 1.87         | 28.8      | 3.36         | 10.2    | 2.315        |
| 1.2    | (5.4)    |              | 23.6      | 3.16         | (8.4)   |              |
| 1.3    |          |              |           |              | 7.35    | 1.99         |
| 1.4    |          |              | 20.8      | 3.035        |         |              |
| 1.5    | 4.11     | 1.43         | (19.4)    |              | 6.62    | 1.89         |
| 1.6    |          |              | 18.0      | 2.89         |         |              |
| 1.8    |          |              | 15.8      | 2.76         | 5.26    | 1.66         |
| 2.0    | 2.86     | 1.05         | 14.2      | 2.65         | 4.58    | 1.52         |
| 2.2    |          |              | 12.2      | 2.50         |         |              |
| 2.3    |          |              |           |              | 3.72    | 1.31         |
| 2.4    |          |              | 11.2      | 2.42         |         |              |
| 2.5    | 2.08     | .733         |           |              | 3.36    | 1.21         |
| 2.6    |          |              | 9.0       | 2.20         |         |              |
| 2.8    |          |              | 8.5       | 2.14         | 2.84    | 1.04         |
| 3.0    | 1.60     | .469         | 6.7       | 1.90         | 2.56    | .714         |

tested purity of 0.99998 and their thicknesses were uniform to within  $\pm 0.002$  millimeter. It is clearly evident that for the curves shown there is no straight portion up to a copper filtration of 3 mm., although it is apparent that they are asymptotically approaching a straight line. A large number of other such curves were obtained under varying conditions of the distance  $B$  and the diaphragms  $M$  and  $N$ , and all were exactly similar to those shown.

In order to be certain that no peculiarity of this system could be responsible for the form of these curves, I have obtained through the courtesy of Dr. Failla and of Dr. Quimby, of Memorial Hospital, New York City, the set of absorption curves for

tube potentials up to 200 K.V., shown in Figure 3. These were made some months previously with a thimble air wall ionization chamber differing slightly in construction from that used at the Bureau. Here also it is clearly evident that the absorption curves do not become straight.

Attention may also be called to a paper by Rump,<sup>33</sup> in which is given a similar series of absorption curves for potentials up to 150 K.V. (Fig. 5 in his article). Again, it is found that the curves are non-rectilinear. In view of the excellent agreement of these different workers there seems no question of the validity of the results.

The same type of copper-absorption meas-

<sup>33</sup>W. Rump, Ztschr. f. Phys., 1927, XLIII, 254; 1927, XLIV, 396.

urement was next made with several thimble ionization chambers placed at various distances from the filter, but all for the same beam of radiation. It must be pointed out that the precision of observation with such

ing the filter position. For the standard ionization chamber no measurable effect was produced by moving the filter from 0.5 to 30 cm. from the entrant diaphragm. However, shifting the filter over the same range

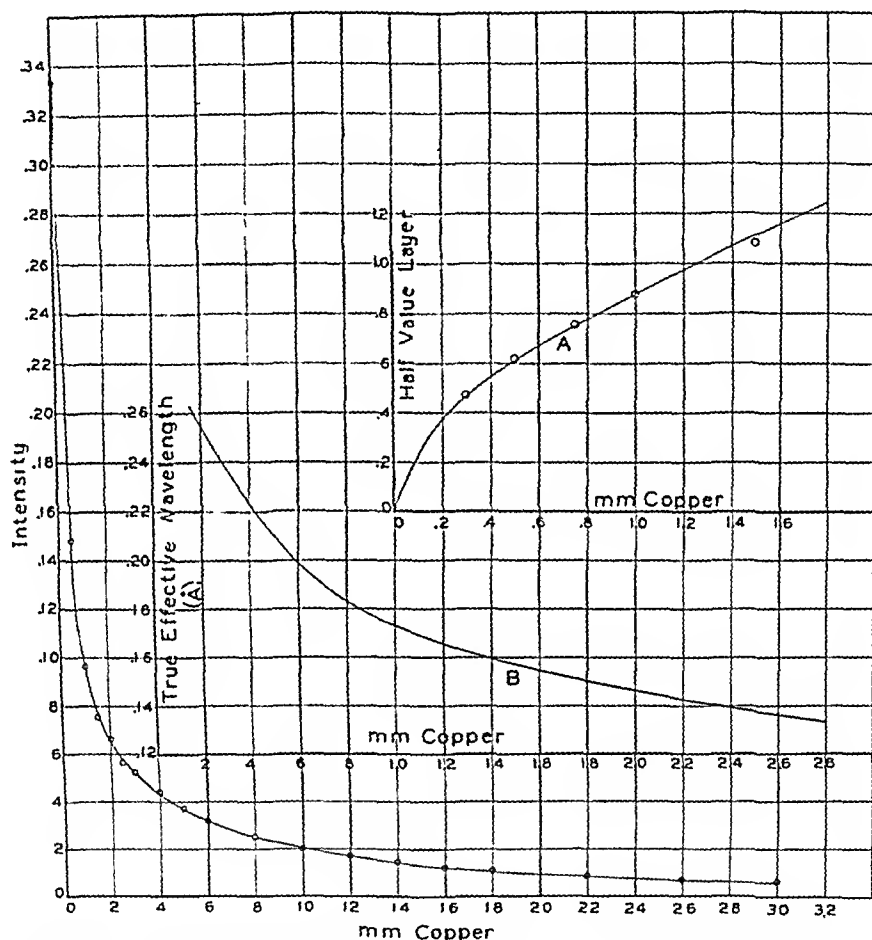


Fig. 5. Curves showing half value layer and true effective wave length obtained from the same absorption curve.

chambers is not as great as with a standard air chamber, and consequently we can not place the same reliance on the measurements made with them.

In order to be certain that the position of the ionization chamber with respect to the filter did not influence the measurements, a series of intensity readings were made, keeping the chamber fixed and chang-

ing the filter position. For a thimble chamber, the measured intensity fell off steadily up to a distance of about 10 cm., where it reached a steady value. Consequently, all measurements with a thimble chamber were made at least 15 cm. from the filter.

In Figure 4 are shown three semilogarithmic absorption curves: *S*, obtained with a standard; *G*, with a Glasser thimble cham-

ber, and  $F$  with a Friedrich thimble chamber. The X-ray tube was operated at 133 K.V., D.C., for all. The standard chamber was set 45 cm. from the filter and the Glasser chamber and Friedrich chamber at about 15 centimeters.

The original data for these curves are given in Table I. The intensities  $I_F$  and  $I_G$ , as measured with the Friedrich and Glasser chambers, respectively, have each been corrected for a very small natural leakage. There was no measurable leakage in the standard chamber system. Half value layers obtained from these data were in good agreement with Holthusen's curves for the voltage used,<sup>34</sup> both measurements being made with a standard chamber.

It is seen that the curve obtained with the standard chamber does not become straight for filtration up to at least 3 mm. of copper. For Curve  $F$ , obtained with the Friedrich chamber, however, it is equally possible to pass a straight line or a slightly curved line through the points above 1 mm. filtration. Likewise for Curve  $G$ , obtained with the Glasser chamber, the points above 1.5 mm. could be joined by a straight or curved line, although the former is perhaps the better of the two. Straight lines are shown in both cases to illustrate a possible explanation for the absorption curves shown invariably by Mutscheller, his curves usually having been obtained with thimble chambers.

If now we measure the slopes of the curves, we find that  $F$  and  $G$  have straight portions with slopes  $-6.80$  and  $-6.28$ , respectively. The points marked  $f$  and  $g$  on the standard absorption curve have also these slopes of  $-6.80$  and  $-6.28$ , respectively. Thus for a given beam of X-rays we apparently find an absorption coefficient which varies considerably according to the technic used in measuring it. To attain uniformity the most logical consequence seems to be to discard the thimble chamber as a means for making precise measurements:

for, inasmuch as the open air chamber is free from wall effects and is the accepted standard, it is apparently the best available means for making absorption measurements of the general radiation.

Where, in practice, a thimble chamber is used in making precise quality measurements, care should be taken to correct for the wall effect.

## 2. Comparison of Quality Measurements

Having reviewed the methods of making quality measurements, we shall now compare the results obtained by applying each method to the same heterogeneous beam of X-rays generated by a practically constant potential source of voltage.

In order to better co-ordinate this comparison we shall refer all measurements of quality to those of the so-called true effective wave length without meaning to imply thereby that this method is preferable or necessarily the most correct. It is, however, less arbitrary than other methods.

Through the courtesy of Prof. H. Holthusen, of Hamburg, a family of curves was available, showing the relation between the half value layer in copper and the tube voltage (constant) for a series of filtered radiations. Half value layers were obtained from each of his curves at points corresponding to 130 K.V. and plotted as circles in the H. V. L. curve. (Inset A in Fig. 5.) The excellent agreement of our experimental results with Holthusen's shows the reliability of the H. V. L. method for constant potential, and gives further proof of the correctness of our above-mentioned experimental procedure.

We may now make a simple comparison of the effective wave length obtained by the slope and bracket methods. For example, if we were to take as the absorption coefficient the slope of the line joining the two points  $a$  and  $b$  on the absorption curve (Fig. 1), corresponding to filters of 0.5 and 1.5 mm. of copper, this would give the slope cor-

<sup>34</sup>H. Holthusen, *RADIOLOGY*, 1928, X, 202.

TABLE II

| Filter | Slope $\mu$       | True $\lambda_e$ | Bracket $\lambda_e$ |             | Equivalent filter | Duane $\lambda_e$ | H. V. L. Cu |
|--------|-------------------|------------------|---------------------|-------------|-------------------|-------------------|-------------|
|        |                   |                  | $\mu$               | $\lambda_e$ |                   |                   |             |
| (1)    | (2)               | (3)              | (4)                 | (5)         | (6)               | (7)               | (8)         |
| mm.    | cm. <sup>-1</sup> | Å.               | cm. <sup>-1</sup>   | Å.          | mm.               | Å.                | mm.         |
| 0.1    |                   |                  |                     |             |                   |                   | 0.238       |
| .2     | 25.5              | .0256            |                     |             |                   |                   |             |
| .25    | 22.8              | .243             |                     |             |                   |                   |             |
| .3     | 19.9              | .230             |                     |             |                   |                   | .475        |
| .4     | 17.5              | .224             |                     |             |                   | 0.183             | .56         |
| .5     | 15.4              | .207             | 28.0                | 0.262       | 0.15              | .178              | .62         |
| .6     | 14.4              | .202             | 16.6                | .214        | .45               | .172              | .68         |
| .7     | 12.8              | .192             | 13.8                | .198        | .6                | .168              | .73         |
| .8     | 11.4              | .184             | 12.2                | .189        | .7                | .164              | .79         |
| .9     | 10.5              | .178             | 11.3                | .183        | .8                | .161              |             |
| 1.0    | 9.86              | .174             | 10.5                | .178        | .9                | .158              | .86         |
| 1.1    | 9.25              | .170             | 9.6                 | .172        | 1.05              |                   |             |
| 1.2    | 8.64              | .165             | 9.0                 | .168        | 1.15              | .153              | 1.00        |
| 1.3    | 8.40              | .163             | 8.5                 | .164        | 1.25              |                   |             |
| 1.4    | 7.94              | .160             | 8.1                 | .161        | 1.37              | .148              | 1.04        |
| 1.5    |                   |                  | 7.8                 | .158        | 1.45              | .144              |             |
| 1.6    | 7.53              | .156             |                     |             |                   |                   | 1.18        |
| 1.7    |                   |                  | 7.2                 | .153        | 1.8               |                   |             |
| 1.8    | 7.15              | .153             |                     |             |                   |                   |             |
| 1.9    |                   |                  | 6.7                 | .148        | 1.9               |                   |             |
| 2.0    | 6.42              | .146             |                     |             |                   |                   |             |
| 2.1    |                   |                  | 6.2                 | .144        | 2.1               |                   |             |
| 2.2    | 5.98              | .142             |                     |             |                   |                   |             |
| 2.4    | 5.80              | .140             |                     |             |                   |                   |             |
| 2.6    | 5.40              | .136             |                     |             |                   |                   |             |
| 2.8    | 5.25              | .134             |                     |             |                   |                   |             |

responding to a filtration of 0.9 mm. at the point C instead of at 1 millimeter. If the points 1 and 2 mm. were chosen instead, the effective wave length would be much more nearly the correct value at 1.5 millimeters. For small filtrations the error in the bracket type of measurement is considerable. Above a certain filtration the method may be sufficiently accurate for many purposes. It has the advantage of requiring but two measurements.

From Equation (8) the absorption coefficient  $\mu$  is given by

$$\mu = \frac{1}{x} \log_e \frac{(E')}{(E'')} \quad (10)$$

where  $(E')$  and  $(E'')$  are the intensities after passing through the two copper filters differing in thickness by  $x$  centimeter. If, for example, we wish to find  $\mu$  for 133 K.V.

radiation filtered through 1 mm. of copper, we have from Table I, Column 3,  $\log_e (E') = 2.44$  for filter 0.5, and  $\log_e (E'') = 1.43$  for filter 1.5 millimeters. This gives  $\mu = 10.1$  and  $\lambda_e = 0.174$  Å. Comparing this with the true effective wave length for 1 mm. copper filtration (Table IV, Column 3) we find a value of 0.169 Å. for the true effective wave length, a fairly good agreement.

A series of values of  $\lambda_e$  for 130 K.V. radiation obtained by the bracket method (where  $x = 1$  mm.) are given in Table II.

A summary of the absorption measurements is shown in Table II wherein all the calculations are taken from the absorption curve at 130 K.V. (Fig. 1). Column 2 gives the slope of the curve at points corresponding to the different thicknesses of

the copper filter indicated in Column 1. Since the curves were plotted with Napierian logarithms, Column 2 thus gives directly the coefficient of absorption  $\mu$  for each quality of radiation. Column 3 gives the corre-

curve, corresponding to a filter separation of 1 millimeter. The intermediate filtration of the two is that shown in Column 1. Column 5 gives the effective wave lengths corresponding to the absorption coefficients of

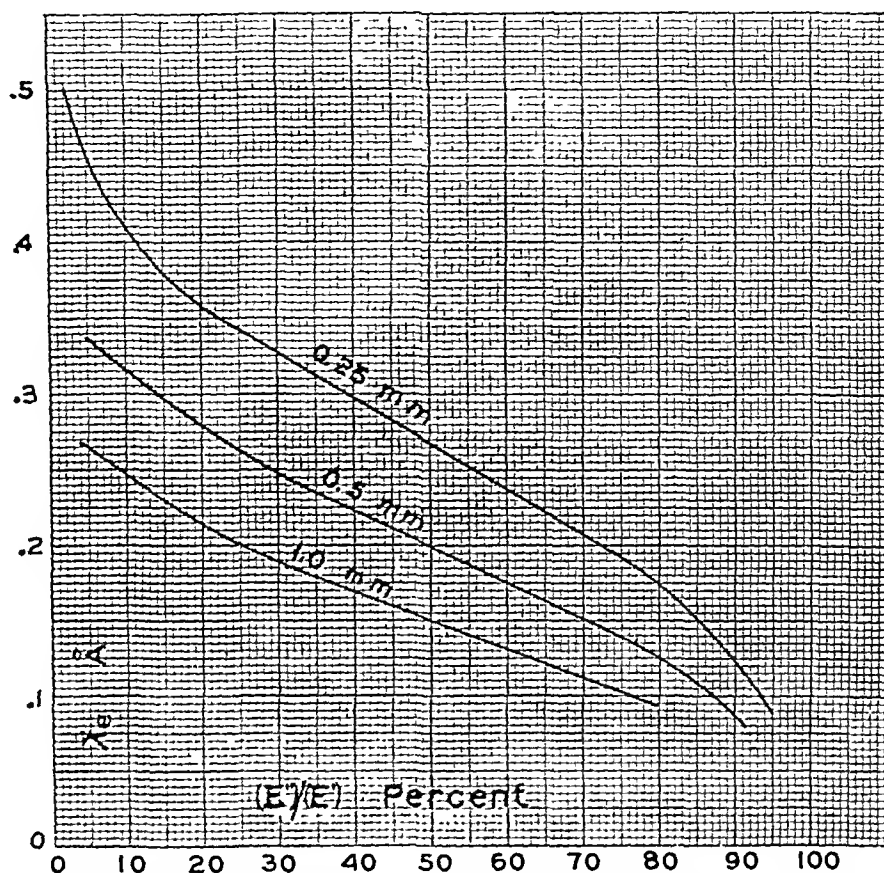


Fig. 6. Effective wave length as a function of the percentage transmission through given filters of finite thickness.

sponding true effective wave lengths when the values of  $\mu$  are put in Richtmyer's copper absorption coefficient curves for monochromatic radiation. From this it is seen that the effective wave length varies appreciably for filtrations up to 2.8 mm. at least. A plot of the effective wave lengths is shown in Inset B of Figure 5.

Column 4 gives the value of the absorption coefficient obtained by the "bracket" method (Sec. II, 2 (a)) wherein the coefficient is given by the slope of the line joining two points on the logarithmic absorption

Column 4, from which it is seen by comparison with Column 3 that, as should be expected, the values approach the same limit for higher filtrations. Column 6 gives the approximate filter thickness on the true absorption curve for the effective wave lengths of Column 5, thus indicating the divergence in terms of filter thickness. For example, consider a beam having an initial filtration of 0.6 mm. copper. Its true effective wave length is 0.202 Å., whereas that derived by the "bracket" method is 0.214 Å. and would correspond to a filtration of about 0.45 mm.

on the logarithmic absorption curve. Such a discrepancy shows at once that the bracket method, using a filter separation of 1 mm., is not satisfactory for obtaining effective wave lengths in close agreement with the true effective wave length except for higher filtrations.

Column 7 gives the effective wave lengths obtained by Duane's method, using a 1 mm. filter separation, from which it is seen that the difference between  $\lambda_e$ , as obtained by the slope of the curve and as obtained by Duane's method, is large over the whole range of filtrations used. Applying the same measurements, however, we obtain a fairly good measure of  $\lambda_e$  for the radiation corresponding to the average filtration. Thus for 0.7 mm. initial filtration, the true effective wave length is 0.192 Å.; by the 1 mm. bracket method, 0.198 Å., whereas by Duane's (1 mm.) method, 0.168 Å. When comparing Duane's effective wave length using 0.25 mm. copper with the true effective wave length, the differences are not large except for unfiltered or lightly filtered radiation.

From the practical standpoint we must not ignore the advantages of Duane's method. It requires but two intensity measurements with given filters and reference to a predetermined calibration curve; it is sufficiently accurate for many of the present-day medical needs.

The half value layers in copper for the same radiation are given in Column 8 and it

is seen that, throughout the entire length of the absorption curve, these are decreasing continuously at least up to an initial filtration of 1.6 millimeters. The data of Column 8 are plotted in Insert A of Figure 5. As pointed out in (II, 2 (c)), there can be no fixed relation between the half value layer and effective wave length except for strictly constant potential X-rays. Curves showing the relation between the two have been given by Neeff and Reisner<sup>35</sup> and others under different conditions, but none lead to any co-ordinated relationship.

Table III shows the results of determining the effective wave length of the unfiltered radiation by Duane's method, using both a standard (S) and a thimble (F) ionization chamber for the intensity measurements. Column 1 indicates the type of chamber used; Column 2 is the filter thickness used in the determination of  $\lambda_e$ ; Column 3 gives the percentage transmission of the respective filters for which are given the corresponding values of  $\lambda_e$  in Column 4, obtained from Duane's curves for effective wave lengths.

It is interesting to note, for lightly filtered radiation, how dependent is the measurement of  $\lambda_e$  on the type of ionization chamber used. For example, in the first case  $\lambda_e$  differs by 8.1 per cent for the two chambers, while the respective percentage transmis-

<sup>35</sup>T. C. Neeff and A. Reisner, *Strahlentherapie*, 1929, XXXII, 190.

TABLE III

| Chamber | Filter  | $E/E_0$  | $\lambda_e$<br>(Duane) | Percentage<br>difference<br>$E/E_0$ | Percentage<br>difference<br>$\lambda_e$ | $\lambda_e$ calculated |
|---------|---------|----------|------------------------|-------------------------------------|---|------------------------|
| (1)     | (2)     | (3)      | (4)                    | (5)                                 | (6)                                     | (7)                    |
|         | mm.     | Per cent |                        |                                     |   |                        |
| S       | 0.25 Cu | 17.7     | 0.37                   | {                                   | 22.4                                    | {                      |
| F       | 25 Cu   | 23.3     | .34                    |                                     |   |                        |
| S       | 1.0 Cu  | 6.5      | .26                    | {                                   | 30.9                                    | {                      |
| F       | 1.0 Cu  | 9.4      | .24                    |                                     |   |                        |
| S       | 2.0 Al  | 41.8     | .47                    | {                                   | 11.6                                    | {                      |
| F       | 2.0 Al  | 47.3     | .45                    |                                     |   |                        |
| S       | 4.0 Al  | 27.4     | .41                    | {                                   | 15.1                                    | {                      |
| F       | 4.0 Al  | 32.3     | .40                    |                                     |   |                        |

tion coefficient  $\mu$  of the radiation by some means and from this the wave length of monochromatic radiation having the same  $\mu$ . For certain ranges Pohle and Barnes found that Duane's effective wave length curves

mined over the full range needed to determine  $\lambda_e$  for all the radiations used in X-ray therapy.

It seems reasonable, therefore, to recommend that the absorption coefficient in cop-

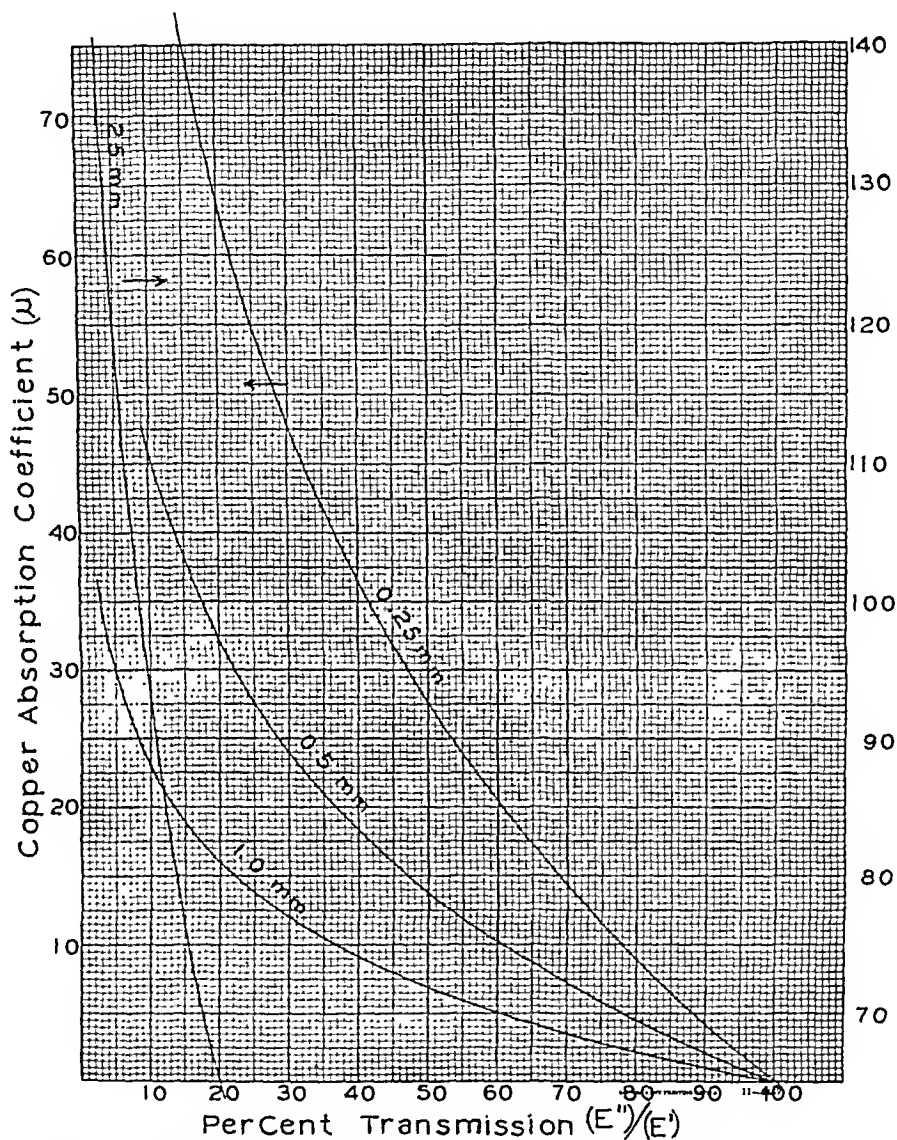


Fig. 7. Copper absorption coefficients as a function of the percentage transmission through given filters of finite thickness.

Note that the curve for 0.25 mm. filter is in two parts.

were inadequate, and consequently expressed  $\lambda_e$  in terms of the percentage transmission of a given filter—a physically undesirable procedure. The fact remains that at present the monochromatic wave length copper absorption coefficients have not been deter-

per or aluminum of a heterogeneous beam of X-rays be used alone to express the quality, stating the methods used in its determination. If desired at any future time, it is then a simple matter to express from available data the effective wave length in the

ranges where possible. Such a method would, for example, eliminate any confusion in Pohle and Barnes' tables.

As shown in (II, 1), the most accurate value of the composite absorption coefficient is obtained when using an infinitesimal filter thickness. The degree of agreement between this and one of the finite filter methods has been shown in Table II.

In practice,  $\mu$  may be determined (1) directly from the slope of the copper absorption curve, giving the true absorption coefficient; (2) by Duane's method, giving an approximate absorption coefficient, and (3) by the bracket method, giving a value in closer agreement with the true absorption coefficient. The first requires a series of measurements. The second and third require but two measurements and  $\mu$  is calculated from Equation (10).

For reference, Figure 7 gives curves for the absorption coefficient as a function of the percentage transmission of several thicknesses of filter which may be used in applying Methods 2 and 3, above. These apply for a filter of any material but care must be taken that the material and thickness are always specified.

#### V. SPECTRAL ENERGY DISTRIBUTION AS DEDUCED FROM COPPER ABSORPTION MEASUREMENTS

We may now turn to one other application of the foregoing copper absorption measurements, namely, the determination of a qualitative picture of the energy distribution in a beam of filtered heterogeneous radiation without the use of a spectrometer.

The effect on an X-ray beam of adding successive layers of a filtering material (copper, for example) is to reduce the intensity of all incident wave lengths according to the absorption law expressed in Equations (3) and (3a). As seen from this equation, the greatest absorption occurs in the longer wave lengths, so that by increas-

ing the filter thickness the energy becomes relatively more and more concentrated in the shorter, more penetrating wave lengths.

If, to take a particular case as an example, a tungsten target X-ray tube be operated below the critical voltage (70 K.V.) at which the characteristic  $K$  series of lines appear, the effect of increased filtration is such that the maximum of the spectral energy distribution curve of the filtered radiation shifts steadily toward shorter wave lengths. It would be expected that for such conditions a logarithmic plot would approach asymptotically a straight line, the slope of which is the  $\mu$  for the short wave length limit. Since this would require that the remaining energy be practically zero, we would not expect the absorption curve to become straight for filtrations ordinarily used (0 to 3 mm. copper).

However, in the case of operating the same tube well above its critical voltage, for example, at 150 to 200 K.V., the  $K$  lines will be present and conditions altered. The effect now of increased filtration is again to reduce the energy at all wave lengths, the resulting energy distribution being dependent upon the voltage and filtration; but, in general, the energy transmitted through thick copper filters will consist of several practically monochromatic lines—the several  $K$  lines and the “end” radiation at the short wave length limit.

At present we have no very accurate data concerning the relative intensity of the  $K_{\alpha}$  lines in comparison with the continuous spectrum background. There will always be present a certain amount of this radiation of shorter and less easily absorbed wave lengths, and it is thus impossible to state in advance the expected form of the logarithmic copper absorption curves for such radiation after high filtration. Only if the amount of continuous radiation were negligible, compared with that of the line radiation, could it be expected that the absorption curve would become straight, thus indicat-



ing a constant absorption coefficient  $\mu$ . At tube potentials of the order of 150 K.V. it has been tacitly assumed by some workers that a large part of the spectral energy comes from the  $K\alpha$  lines of tungsten which appear at wave lengths of about 0.2 Å., thus accounting for a straight end to the absorption curve. However, such a distribution of energy, even in highly filtered radiation, is contrary to experience.

Having obtained values of  $\lambda_e$  for copper filtrations up to 3 mm. we see that the effective wave length of 130 K.V. radiation does not approach the wave lengths of the tungsten  $K\alpha$  lines which occur at about 0.208, 0.213, 0.184, and 0.179 Å., respectively. The nearest approach of  $\lambda_e$  to these wave lengths occurs for about 0.6 to 0.8 mm. of copper filter; whereas, for the maximum filtration used,  $\lambda_e$  was about 0.134 Ångström. This is a reasonable value of  $\lambda_e$ , since for the voltage used the minimum wave length  $\lambda_0$  of the spectrum is 0.095 Ångström. The fact that  $\lambda_e = 0.134$  Å. is nearer  $\lambda_0 = 0.095$  Å. than the wave length of the  $K$  lines gives further indication that the larger part of the energy passing through the filter is not that of the  $K$  lines, but that of the continuous spectrum background instead.

As a qualitative check of the above reasoning, we may refer to some approximate spectral energy distribution curves obtained by Duane<sup>23</sup> with an ionization spectrometer. The curve shown was made at 161 K.V. (constant potential) and 1 mm. of copper, and it is shown thereby that the greater part of the remaining energy apparently lies at shorter wave lengths than the first-order tungsten lines.

## VI. SUMMARY

1. A qualitative theory of copper absorption measurements shows that, for a known spectral energy distribution, an effective wave length may be determined which

is definitely related through known absorption laws to that distribution.

2. The logarithmic copper absorption curves for heterogeneous high voltage X-radiation do not become straight for filtrations up to 3 mm. copper when the measurements are made with a standard ionization chamber.

3. Absorption measurements, applied to the problem of describing the quality of a heterogeneous beam of X-rays, show (a) that measurements of the so-called "average wave length" of the radiation have no meaning as long as they are based strictly on the logarithmic absorption curve becoming straight for filtrations greater than the "homogeneity filter"; (b) the "half value layer" method of expressing quality is sensitive at least up to 1.6 mm. copper filtration but is readily reproducible only for strictly constant voltage applied to the X-ray tube; (c) the most logical expression of the "effective wave length" is obtained when using the absorption coefficient given by the slope of the logarithmic absorption curve. This is called the true effective wave length.

4. Duane's method for obtaining the effective wave length gives values consistently lower than the true effective wave length, although the difference is not great enough at higher filtrations to have any significance for most medical work. If this method is employed, the thickness of copper used in the measurement should be stated.

5. The bracket method for determining the effective wave length is more accurate than any other approximate method, but requires one more observation than the Duane method.

6. Absorption measurements made with the more common form of thimble ionization chamber are subject to error due to the chamber "wall effect." Such error is minimized in the true effective wave length method.

7. The absorption coefficient obtained with a standard thickness of copper (or alu-

minum) is recommended as the simplest general method of describing the quality of a heterogeneous beam of X-rays for therapeutic uses. Due to a lack of monochromatic wave length absorption data over a sufficient range, it is impossible to extend the effective wave length method over the whole range of radiations encountered in X-ray therapy. Thus, for a perfectly general physical definition of quality, the "true" absorption coefficient obtained from the

slope of the absorption curve is recommended.

8. The effect on heterogeneous tungsten radiation of increasing the copper filtration is the concentration of the major part of the transmitted energy in wave lengths shorter than the *K* series of lines.

Recognition is due G. Singer, of this Laboratory, for having carried out the experimental part of this work.

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# COLOR CHANGES PRODUCED BY ROENTGEN RAYS IN SOME AQUEOUS SOLUTIONS

CONSIDERED FOR DOSAGE MEASUREMENTS AND FOR DETECTION OF EFFECTS OF RADIATION ON OTHER CHEMICAL COMPOUNDS

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CHEMICAL effects produced by roentgen radiation have been studied during the past years by several investigators. Changes have been produced in a number of compounds, as has been pointed out in a recent article by Clark and Pickett (1). As a rule, very minute quantities are changed chemically by the roentgen dose which can be applied in a reasonable length of time. It is, therefore, not surprising that some of the substances irradiated seem to have been unaffected. Whether no change at all took place, or whether the methods for detecting the change were not delicate enough, remains to be determined. The studies to be described here may lead to a delicate method for detecting chemical effects of the radiation and a method which may perhaps be applied to a great number of substances.

Our investigations were at first aimed mainly at finding a simple method for measuring roentgen-ray dosage. Considering that some color change might be found that would be satisfactory for this purpose, we started to investigate the effect of radiation on solutions of a number of chromatic substances.

Color changes produced by roentgen rays have long been utilized as a means of measuring radiation quantitatively. The Sabouraud-Noiré (2) dosimeter is based on this principle. Solids of fairly high average or effective atomic weights are used in this as well as in other similar dosimeters. Aqueous solutions should be better for two reasons: (a) water absorbs and scatters roentgen rays to about the same extent as tissues, and (b) the color change in solutions

can be measured accurately by means of colorimeters, or, still better, by spectrophotometers.

Fricke and Morse (3) have described how the oxidation of ferrous sulphate in a 0.8 N sulphuric acid solution can be used for measuring dosage, and we have used this method to find out how much roentgen radiation was absorbed in the different solutions we examined. The main practical objection to this method is that the amount of  $\text{FeSO}_4$  oxidized has to be determined in a rather complicated way. Recently Wyckoff and Baker (4) have found that the action of roentgen rays on Eder's solution [ $\text{HgCl}_2$  ( $\text{NH}_4$ ) $_2$   $\text{C}_2\text{O}_4 \rightarrow \text{HgCl}$ ] may be utilized for measurements of dosage. It is, however, rather questionable whether this method can be made practical, though attempts in this direction have been made (5).

Fricke found that the amount of  $\text{FeSO}_4$  oxidized per cubic centimeter of solution was directly proportional to the dose, and independent of the concentration. The same relation was found by Clark and Pickett (1) to hold for the reduction of potassium nitrate to nitrite. We have obtained similar relations for tyrosine (5) and phenol. As very small amounts are changed it is evident that at least for certain compounds it is best and often necessary to use very dilute solutions in order that it may be possible to measure the effect of the radiation. We consequently used only substances which gave a strong color in weak solutions.

After some experimentation we decided that it was of advantage to use a tube 10 cm. long for the measurements of the color change, and that the solution in such a tube

should have a decided and easily measurable absorption band in the visible part of the spectrum before it was irradiated. The concentration for each substance had to be regulated to suit these conditions. The following were selected for a test: methylene

only one of the substances discussed here which showed a decided increase in absorption. Unfortunately, it is unstable in this concentration even when kept in the dark. It was studied rather thoroughly and shall, therefore, be mentioned again.

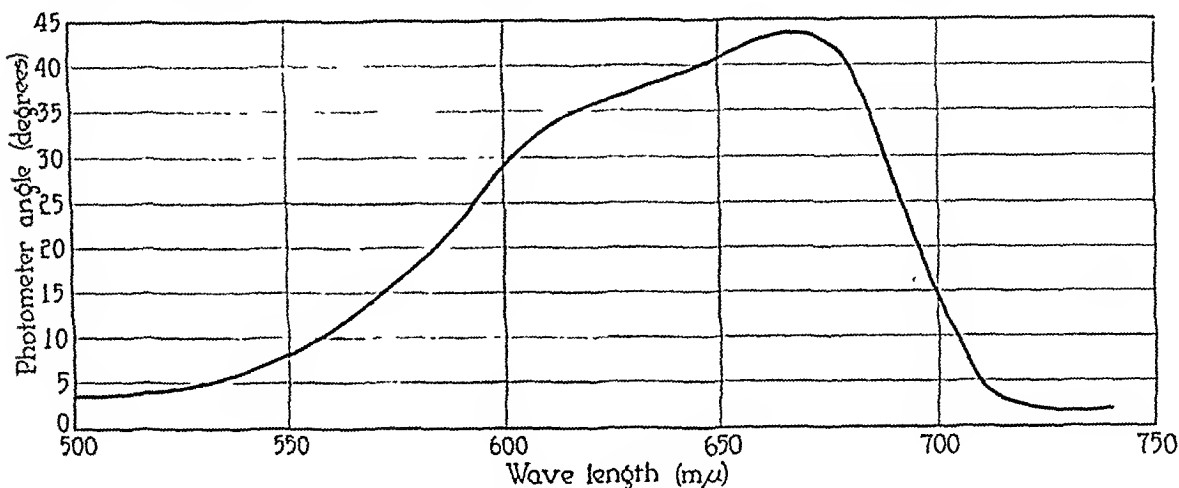


Fig. 1. Absorption curve for methylene blue.

blue, potassium dichromate, potassium permanganate, gentian violet, acid fuchsin, ferric ammonium citrate 1 per cent, cupric nitrate 1 per cent, nickelous chloride 1 per cent, and cobaltous chloride 1 per cent. The last four of these compounds had to be used in comparatively concentrated solutions and (probably as a consequence) showed no appreciable change after one hour of irradiation. Mercurochrome, erythrosine, and eosine did not seem to be especially influenced either. Gentian violet showed a definite decrease in absorption after irradiation (1 c.c. saturated ethyl alcohol solution in 10 liters  $H_2O$ ), but not as much as methylene blue. Acid fuchsin showed a decided reduction of the absorption band between 460 and 580 mμ. It also did not change as decidedly as a 0.00016 per cent aqueous solution of methylene blue, which will be considered in greater detail later. Neither did potassium dichromate prove to be as sensitive. Potassium permanganate in a 0.001 N solution was very sensitive to radiation. It is the

Before the results are discussed further it seems advisable to describe how the experiments were carried out. Radiation given off from a high voltage therapy tube was utilized while patients were being treated. The solutions were placed in specially made glass tubes. For some of the experiments the tubes were sealed off by a flame after about 20 c.c. of the solution had been poured in. These tubes measured 1.5 to 1.7 cm., inside diameter, and about 15 cm. in length, with a wall thickness of about 0.13 centimeter. For other experiments 50 c.c. of the solution were poured into glass tubes equipped with ground glass stoppers. These tubes measured 17–19 cm. in length, 2.3 cm. inside diameter, with a wall thickness of about 0.13 centimeter. For most of the experiments the glass was painted black so that no light could reach the solutions. The glass tubes were placed inside the container in which the roentgen tube was housed (an Acme-International tube stand), at a distance of about 60 cm. from the center of the

tube to the target. They were laid down all in the same position with the top away from the target and 1 cm. higher than the bottom. Usually one of the tubes was kept in a lead capsule and served as a control. In order to determine the amount of roentgen radiation absorbed by a weak solution in such glass containers per hour of radiation, some of them were filled with 0.001 N  $\text{FeSO}_4$  in 0.8 N  $\text{H}_2\text{SO}_4$ . The dose absorbed was measured in a manner similar to the one used by Morse and Fricke (3), using the value of 0.0027 mg.  $\text{FeSO}_4$  per c.c. oxidized by one kilo roentgen, which value was calculated from their data. Two hundred K.V., 30 ma., and no filter except the glass wall of the container were used. About 8 kilo roentgens were thus found to be the dose given the solution per hour. Independently of the absolute dose, this method gives a good comparison between the oxidation effect on  $\text{FeSO}_4$  and the other effects studied.

In order to determine quantitatively the light absorption of the solutions, a Bausch & Lomb spectrophotometer was used, consisting of a constant deviation spectrometer and a Marten's polarization photometer. An unirradiated sample of the solution was always measured immediately before or after the measurements were taken of a sample of the same solution which had been exposed to roentgen rays.

A 0.0002 molar solution of  $\text{KMnO}_4$  is strongly colored purple. It has a wide absorption band in the yellow, green, and blue, with a maximum at about 530  $\text{m}\mu$ . The band is so intense that it seemed quite black between 510 and 560  $\text{m}\mu$  when a 10 cm. absorption tube was used. A 5 cm. tube permitted fair readings and was, therefore, used instead for this particular solution. An exposure of 15 minutes to roentgen rays showed a decided effect, in that the absorption below 500  $\text{m}\mu$  increased to an extent that was easily measurable. The absorption towards longer wave lengths remained practically unchanged, however. The in-

creased absorption toward shorter wave lengths is due to a formation of  $\text{MnO}_2$  (7). This was the most sensitive reaction we found but it did not seem practical to use it, as the  $\text{KMnO}_4$  in such a weak solution is so unstable that it is changed to some extent even when kept in the dark.

Of all the substances tried, methylene blue seemed to be the most promising. It was used in different concentrations, and, of these, 0.0016 mg. per c.c. was the most favorable one when used in a 10 cm. absorption tube. Figure 1 gives the light absorption curve of this solution when the wave length measured in  $\text{m}\mu$  is used as abscissa and the angle of the photometer is used as ordinate,  $45^\circ$  being complete absorption, and  $0^\circ$  no absorption. When the solution was irradiated the absorption was gradually reduced, but the shape of the curve was retained except in the green region of the spectrum. It seemed, therefore, unnecessary to take measurements at more than two or three wave lengths and it was decided to measure the amount of absorption quantitatively at 665, 620, and 520  $\text{m}\mu$ . The percentage of methylene blue disappearing (as indicated by the color) can be calculated by means of the formula,

$$\frac{C_1}{C_2} = \frac{\log T_2}{\log T_1};$$

where  $C_1$  and  $C_2$  refer to the concentration before and after irradiation, respectively, and  $T_1$  and  $T_2$  to the corresponding transmission.  $T = \tan \Theta_1 \times \cot \Theta_2$ ; where  $\Theta_1$  refers to the angle of the polarization photometer between  $0^\circ$  and  $45^\circ$  and  $\Theta_2$  the angle between  $45^\circ$  and  $90^\circ$  that gives a good match. ( $T = \frac{I'}{I}$  where  $I$  = intensity of incident light;  $I'$  intensity after passing through the solution.) Table I gives the relation between the amount of radiation and the color change of two independent experiments. Column 1 gives the time of exposure to roentgen radiation; Columns 2, 3, and 4 the reading of the photometer for

TABLE I.—METHYLENE BLUE

| Time of exposure<br>(hrs.) | Photometric readings |      |        | Unchanged        |         |      |
|----------------------------|----------------------|------|--------|------------------|---------|------|
|                            | at 520               | 620  | 665 mμ | % (mg. per c.c.) | Log     | %    |
| 0.00                       | 41.1                 | 9.2  | 1.4    | 100              | 0.0016  | 2.00 |
| 0.38                       | 40.7                 | 11.8 | 3.1    | 79               | 0.00126 | 1.90 |
| 0.79                       | 39.4                 | 13.6 | 5.3    | 64               | 0.00102 | 1.81 |
| 1.31                       | 38.7                 | 18.3 | 10.7   | 45               | 0.00088 | 1.65 |
| 1.78                       | 39.4                 | 24.1 | 18.6   | 29               | 0.00046 | 1.46 |
| 2.21                       | 39.8                 | 26.2 | 20.6   | 27               | 0.00043 | 1.43 |
| 2.79                       | 40.7                 | 30.7 | 28.0   | 17               | 0.00027 | 1.23 |
| 0.00                       | 41.7                 | 10.2 | 1.8    | 100              | 0.0016  | 2.00 |
| 0.59                       | 40.5                 | 14.6 | 5.3    | 69               | 0.00110 | 1.84 |
| 1.02                       | 40.1                 | 18.8 | 10.2   | 50               | 0.00080 | 1.70 |
| 1.48                       | 40.0                 | 24.4 | 17.9   | 33               | 0.00053 | 1.52 |
| 2.07                       | 40.1                 | 28.6 | 24.8   | 22               | 0.00035 | 1.34 |
| 2.64                       | 39.0                 | 28.6 | 25.8   | 20               | 0.00032 | 1.30 |
| 3.17                       | 40.5                 | 37.6 | 38.6   | 7                | 0.00011 | 0.85 |
| 4.15                       | 41.0                 | 37.8 | 40.3   | 5                | 0.00008 | 0.70 |

wave lengths 520, 620, and 665 mμ, respectively; Column 5 the percentage of change calculated from the absorption at 665 mμ; Column 6 the concentration of the solution according to the color in mg. per c.c., and Column 7 the logarithm of the percentage of unchanged methylene blue. The percentage of change as a function of the time of exposure is shown graphically in Figure 2-A, which is drawn by inspection. It is evident from the curve that the change is not directly proportional to the dosage as is the case with FeSO<sub>4</sub>. If the logarithm of the percentage of methylene blue unchanged is plotted against the time of exposure the relation seems to be a straight line (Fig. 2-B) as far as the accuracy of the readings permit us to conclude. This is, of course, only a first approximation. This is the same type of relationship that has already been found to hold for the deactivation of trypsin (8) and for the oxidation of oxyhemoglobin to methemoglobin (9). We believe this is due to the formation of substances with little or no light absorption in the measured region, which are decomposed further by the roentgen radiation, thus competing with the methylene blue for the ions produced by the radiation in the water. The stability of the methylene blue solutions was tested in that samples of the solutions were left standing

for one week and then examined again with the spectrophotometer. The samples which had been exposed to the light in the meantime showed slightly diminished absorption, whereas samples which had been kept in the dark showed no change after one week. Thus the methylene blue seemed both stable enough and sensitive enough to be used for measurements of roentgen dosage. This conclusion was contradicted by further experiments, which will be mentioned later. It was objectionable to use a glass container if radiations of different hardness were to be compared with one another.

In trying to find material for suitable containers we decided that kodaloid<sup>1</sup> offered several advantages. Cylindrical containers were made by rolling the material around a rod, dissolving and softening the edges with acetone, and sealing on the bottom piece in the same manner. After the containers were dry the solution was poured in and a cover sealed on. When the solution was irradiated in these containers the change was less than one-half of what it had been in the glass tubes. It seemed possible that a small amount of the acetone had been brought into the solution and that the acetone in competition with the methylene blue had utilized part of the energy supplied by the roentgen rays. A drop of acetone was, therefore, added to the solution in one glass tube and that tube irradiated at the same time as a solution free from acetone. The effect on the methylene blue in the latter solution was several times greater than on that in the former, indicating that the effect of the roentgen radiation had been utilized mainly by the acetone. The acetone did not change the color before irradiation of the solution. This experiment indicated that a very small organic impurity may change the effect on the substance which is being tested, especially

<sup>1</sup>This is a cellulose product which can be obtained in sheets from the Eastman Kodak Company. It is an organic material with about the same absorption and scattering coefficient as water and it can be obtained in very uniform thickness.

when weak solutions are used. It was also a warning that special precautions have to be taken if such solutions are going to be used for measurements of dosage. (If a number of glass tubes, which have been

The figures in the same horizontal lines refer to tubes irradiated together for the same length of time.  $\text{CaCl}_2$  does not influence the amount of change, whereas ethyl alcohol and sucrose reduce the change of

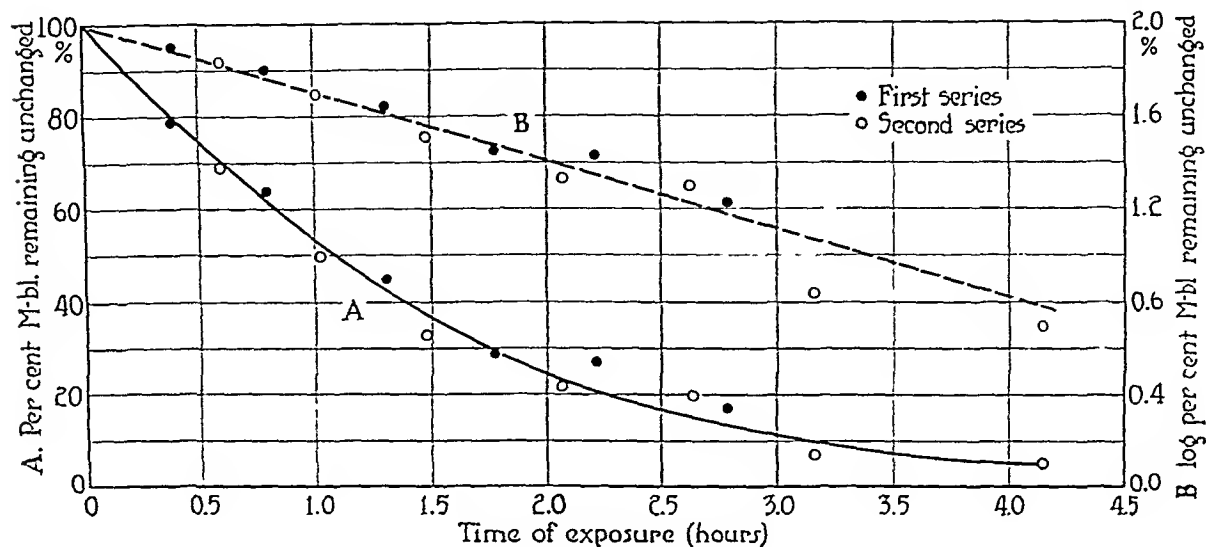


Fig. 2. (A) Decomposition of methylene blue. (B) Logarithmic curve of the decomposition of methylene blue.

cleaned together, are filled with parts of the same solution at the same time, one can, however, be reasonably sure that they can be used for comparison of dosage.) The effect of a small amount of acetone in the methylene blue solution undoubtedly explains why Clark and Pickett failed to get any decomposition of methylene blue dissolved in acetone.

The fact that very small amounts of substances influenced by roentgen irradiation reduce the change of the methylene blue makes such solutions sensitive indicators to test, whether the added substance is affected by the radiation or not. It seems that the method might be worked out for quantitative determinations.

Some preliminary experiments were carried out with ethyl alcohol, sucrose,  $\text{CaCl}_2$ , and phenol as added impurities. The results are summarized in Table II. Each glass tube contained 0.0016 mg. methylene blue and 0.02 mg. of added substance per c.c. of solution.

TABLE II.—PERCENTAGE OF METHYLENE BLUE CHANGED

| With no impurity % | With addition of 0.02 mg. |           |                   |          |
|--------------------|---------------------------|-----------|-------------------|----------|
|                    | Alcohol %                 | Sucrose % | $\text{CaCl}_2$ % | Phenol % |
| 51                 | 19                        | 17        | 51                |          |
| 88                 |                           |           |                   | 30       |
| 98                 |                           |           |                   | 41       |

methylene blue to about the same extent. The quantitative relations have not been studied as yet, but it has been shown that if one-tenth as much of the substance is added as impurity, the influence of it is much more than one-tenth as great. It should be mentioned that it has been discovered before that sucrose and phenol in aqueous solutions are influenced by roentgen irradiation.

Another factor which has a decided influence upon the radiation effect is the hydrogen ion concentration of the solution. Unfortunately we cannot give the exact pH value for the solutions referred to in this article (the methylene blue solutions had a pH

of about 7), but that will have to be determined in further experiments.

The investigation unfortunately had to be interrupted, but we hope to be able to continue the study later. It seems of special importance to point out that small amounts of impurities may have a decided influence on the action of roentgen rays on weak solutions, and, further, that such weak solutions of suitable compounds can be utilized for the indirect study of the effect of roentgen rays on other substances which cannot be measured accurately in such small quantities as usually are to be considered in experiments of this type.

#### SUMMARY

1. Several colored solutions have been irradiated by roentgen rays and the change of color has been measured by means of a spectrophotometer.

2 It was thought that a color change measured quantitatively might be used as a means to determine dosage. Of the substances which were affected to an appreciable extent, methylene blue seemed to be most suitable for this purpose, and was studied further

3 A quantitative relation between the color change and the dose was obtained, but it was found that small impurities of organic substances disturbed this relationship. The hydrogen ion concentration also had a decided influence. Extreme precautions, therefore, have to be taken if such changes

are going to be used for determination of dosage. This undoubtedly is true for whatever chemical method is being used.

4. The change of color produced by roentgen rays was not affected by calcium chloride but was definitely and to about the same extent influenced by small amounts of acetone, ethyl alcohol, sucrose, and phenol. Probably the effect of the radiation is divided between the methylene blue and the impurity, and it may be possible in this way to study the effect on the substance added to the colored solution. Such small amounts are, as a rule, changed by the radiation that for many substances it would be impossible to discover the effect of it by the direct method.

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## ROENTGENOLOGIC CHANGES IN SARCOID AND RELATED LESIONS<sup>1</sup>

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THE disease known as Boeck's sarcoid is characterized primarily by the formation of nodules in the cutaneous and subcutaneous tissues. The skin over these areas has a telangiectatic appearance. The distribution of the lesions and the histologic picture are distinctive. Closely related to this lesion are the diseases known as Darier-Roussy sarcoid, lupus pernio, and erythema induratum. In this group of related diseases there are sometimes accompanying systemic complaints and more or less characteristic lesions in organs other than the skin. Among the systemic lesions that have been described are fibrocystic changes in the bones, infiltration in the lungs, adenopathy of the cervical lymph nodes, splenomegaly, tonsillar swelling, iritis, and infiltrations in the mucous membranes of the upper air passages.

Various hypotheses with regard to the etiology of this disease have been advanced: for example, that it is due to the bacillus of tuberculosis; that it is a separate disease entity, or that several factors are involved.

In certain cases the bacillus of tuberculosis has been isolated from the lesions in the skin, and definite tuberculous lesions have often been found. In other cases there is no evidence of tuberculosis and even the tuberculin test gives a negative reaction. The fact that a general lymphadenopathy sometimes occurs suggests the possibility that the condition is related to lymphoma. The favorable results reported in certain cases following roentgen-ray treatment would tend to substantiate this view. It is Voorhoeve's belief that, since the central nervous system is often involved, the lesions in the bones are

of a trophic nature. He cited, to support this view, observations at necropsy in a case originally reported by Winkler in which there were definite changes in the nervous system.

Because of the fact that Boeck's sarcoid with visceral involvement is seldom fatal, pathologic descriptions of the visceral lesions are meager. Schaumann (13, 14) studied the bones histologically in cases in which the finger or toe had been amputated and reported that the findings strongly resembled those found in bones involved in lymphomatous processes. Hence he called sarcoid with visceral involvement "benign lymphogranuloma." The patient with sarcoid of the lung described by Bernstein, Konzlemann, and Sidlick (2) came to necropsy and lesions were found in the bronchial mucous membrane resembling sarcoid as it occurs in the skin.

The questions of etiology and the relation of the various types of sarcoid to one another are for the dermatologists to settle. Goeckerman (6) has given a very complete summary of the present opinion on these questions. It is, however, important for the roentgenologist to know that in the cases diagnosed as belonging to the sarcoid group there are roentgenologic signs which are more or less characteristic of the condition. These occur as changes in the bones and in the lungs.

### CHANGES IN THE BONES

The first report of involvement of bone in cases of sarcoid lesions as noted by the roentgen ray apparently was that of Kreibich (8), who, in 1904, published a roentgenogram of the hands in a case of lupus

<sup>1</sup>Submitted for publication December 6, 1930.

pernio and gave a brief but accurate description of the roentgenologic data.

Rieder (11) reproduced the roentgenograms in two other cases and since then several European observers have reported cases.

Jüngling (7) described a condition of the bone to which he gave the name of "ostitis tuberculosa multiplex cystica," which was similar to the condition reported by the other writers in cases of sarcoid. Some of his cases were associated with sarcoid. Most of the changes in bone that he described were confined to the phalanges of the hands and feet, but in some the distal ends of the bones of the forearm were involved.

Fleischner (5) reviewed the roentgen-ray data in cases reported prior to 1924 and added seven new cases, in one of which a lumbar vertebra was affected by the sarcoid process.

In this country, Finnerud (4) reported a case and described typical roentgenograms but did not reproduce them.

Goeckerman (6) reported seventeen cases of sarcoid and in several cases reproduced the roentgenograms, showing changes in bone.

Doub and Menagh (3) recently described the roentgen-ray appearance of the bones in two cases that came under their observation.

Sarcoid with organic involvement is apparently a disease of adult life, for among the cases recorded in the literature the average age of thirty patients with sarcoid lesions of the lungs or bone was thirty-six years. Practically all patients were more than twenty years of age. Men and women were equally affected. The disease often has a fairly acute onset and later lapses into a chronic state. Lesions in bone tend to progress, but if the disease is arrested the appearance of the bones may return almost to normal. In other cases considerable permanent loss of bony tissue results.

The roentgenologic changes are usually



Fig. 1 (Case 1). Extremely dense, nodular infiltration in the lower portion of the right lung; moderate linear infiltration extending from left hilum.

in the phalanges of the hand, but the phalanges of the foot are frequently found to be affected. Changes in the lower ends of the radius and ulna, about the elbow joint and even in the body of a vertebra, have been described. The disease of the bone seems to be first evident as thickening of the trabecular architecture in the end of one of the phalanges of a finger. Small punched-out areas appear and later there is a peculiar combination of destruction and repair of bone. Clear cystic areas appear, varying from pin-point size to spaces 1 cm. in diameter. The small trabeculae between the broken-down areas are dense and sclerotic. The whole phalanx may be affected. If the process is arrested and healing occurs, the bone may return almost to normal, but usually considerable mutilation results. No generalized atrophy of bone of the affected hand occurs, and but little localized atrophy of the diseased bone. Sequestration of the diseased part is absent and there is no ac-



Fig. 2 (Case 2). Fibrocystic areas in the second and third phalanges; middle finger of left hand.



Fig. 3 (Case 3). Multiple fibrocystic areas in many phalanges of both hands.

companying periostitis. The neighboring joints are not involved. The shaft of the affected bone may show slight uniform enlargement but the cortex is rarely broken.

Fleischner (5) and Doub and Menagh (3) described two types of roentgen-ray manifestations, according to whether the coarsening of the trabecular architecture or the areas of cystic destruction predominated. It appears likely that these are different stages of the same process. Such roentgenologic pictures must be distinguished from those seen in certain other diseases.

Tuberculous dactylitis, or spina ventosa, is seen mostly in the hands of children. Periostitis and atrophy of bone is marked. Sequestra and discharging sinuses are common.

Osteitis fibrosa cystica is seldom confined to the phalanges: it is more generalized and more progressive than the condition described. Fracture is more likely to occur.

Syphilitic disease of bone, particularly the congenital variety, sometimes affects the phalanges; the lesion is then more often in the diaphysis rather than in the head of the bone. There is some periostitis present and the cortex is thickened.

Malignancy can be ruled out by the multi-

plicity of the lesions and by the fact that the cortex is not broken.

Chondromatosis usually causes much more enlargement of the bone and definite tumors are seen.

#### CHANGES IN THE LUNGS

Kuznitzky and Bittorf, in 1915, gave a careful description of the changes in the lung in certain cases of sarcoid and reproduced roentgenograms in one case. They could not find evidence of tuberculosis in their case and were convinced that they were dealing with a disease *sui generis*. They subsequently observed seven cases in which they attributed changes in the lung to sarcoid.

Bernstein, Konzlemani, and Sidlick (2) reported a case which they considered to be sarcoid in which there was bilateral hydrothorax. The patient died and necropsy disclosed lesions with the histologic appearance of sarcoid in the bronchial mucous membrane.

Assmann in his text-book described the condition in the lungs and cited a case that came under his observation. The lesions in the lung in his case completely disappeared under roentgen-ray treatment.

Goeckerman (6) described the condition of the lung in several cases.

Valenti (16) stated that the pulmonary changes vary with the condition of the sarcoids in the skin. He reproduced roentgenograms taken three years apart which showed considerable improvement concomitant with improvement in the skin. These lesions differed from those described by others and from the cases that came under our observation in that the lesions were mostly in the upper half of the lungs.

Finnerud (4), Rischin (12), Lutz (10), Schinz (15), and Van Husen (17) also reported cases of sarcoid with more or less typical roentgen-ray manifestations in the lungs.

The roentgen-ray appearances that are seen typically in the lungs of these patients consist of bilateral, fairly dense, diffuse linear infiltration of the middle or the lower half of the lungs, extending from the hilum well out toward the periphery. This infiltration may be so dense as to obscure the borders of the heart. Superimposed on this are many discrete opaque areas, ranging in size from miliary nodules to areas perhaps 1 cm. in diameter. The apexes are not affected. Signs of pleurisy or fluid are absent. In some cases the nodes at the hilum are not enlarged and in others enlargement of these nodes is a feature of the roentgen-ray appearance. The picture in the individual case varies according to whether linear infiltrations or scattered nodules prevail.

The condition must be distinguished from other chronic conditions of the lungs. It has some of the characteristics of old fibrous tuberculosis but the apexes are not involved. Pneumoconiosis resembles it more closely, but in this condition the nodules are more definite and more numerous and there is not such a background of linear striations. Although the sarcoid lesions in the lung do not have a tendency to form cavities and are more diffuse than the usual type of bronchi-

ectasis, yet it is often difficult to distinguish between the two conditions.

Cases of Boeck's sarcoid with visceral involvement are not common, and a roentgenologist will not be called on to make such a diagnosis from the roentgen-ray data alone. However, he should know that characteristic lesions may occur in the bones and in the lungs of such patients.

#### ABSTRACT OF ILLUSTRATIVE CASES.

Cases 1 and 4 are illustrative of changes in the bones and in the lungs, Cases 2 and 3, of changes in the bones, and Cases 5 and 6, of changes in the lungs.

*Case 1.*—A woman, aged twenty-eight years, had had sarcoid lesions for seven years. Her general health was good. Roentgenograms of the lungs showed a peculiar infiltration of the bases (Fig. 1), while in the bones of the hands and feet were cystic changes. There were also atrophic rhinitis and enlarged lymph nodes. The spleen was palpable. A diagnosis of sarcoid was confirmed by biopsy. Bacilli of tuberculosis were not found in the sputum and the tuberculin test was negative.

*Case 2.*—A woman, aged forty-two years, had had typical sarcoid lesions for six years. Her general health was good except for iritis. The lungs were normal roentgenologically but fibrocystic changes were noted in the bones of the hands (Fig. 2). The diagnosis was confirmed by biopsy of the skin.

*Case 3.*—A woman, aged fifty-four years, in poor general health, had had sarcoid lesions for six years. Roentgenograms disclosed tuberculosis in the apexes of the lungs and infiltration of the lower part of each lung. Cystic changes were also noted in the bones of the hands and feet (Fig. 3). Active tuberculosis of the larynx was present. This patient died.

*Case 4.*—A man, aged forty-three years, had typical sarcoid lesions on both cheeks. He had also an enlarged spleen, enlarged

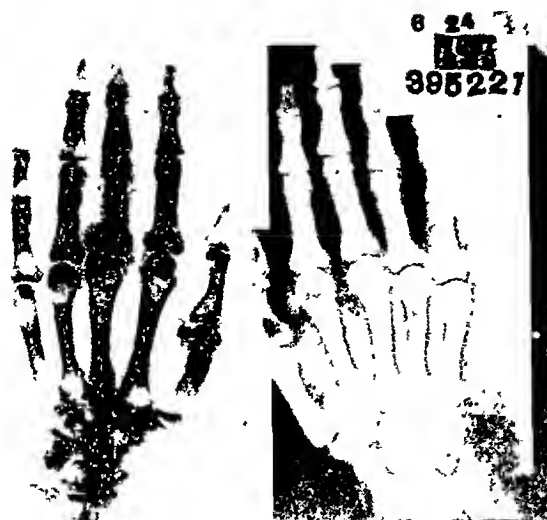


Fig. 2 (Case 2). Fibrocystic areas in the second and third phalanges; middle finger of left hand.



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# ANENCEPHALY; THE IMPORTANCE OF PRE-NATAL DIAGNOSIS, WITH REPORT OF CASE<sup>1</sup>

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**A**N anencephalon is a single monster, the greater part, or all, of whose brain is lacking. The bones of the vault are absent, the structures at the base of the skull are flattened, the eyeballs bulge, and the upper eyelids are unusually large. The shoulders are often larger than usual. The cervical vertebrae have an exaggerated lordosis, giving an extended appearance to the face and head resembling a frog's head.

DeLee (1) states that "single monsters are more frequent than double monsters, and, among the former, anencephalus ranks first." Muff (2) states that according to von Chaussier one monster appears in every 69 labors; von Puech, 1 in 111, and von Winckel, 1 in 64. This makes an average of 1 monster in 81 labors. Muff, in a survey of monsters at the various museums, found that there were nine times as many single monsters as double monsters. Ballantyne (3) in a series of 325 monsters and fetal disease cases had 46 anencephalic monsters (14 per cent). Case and Cooper (4) report 5 cases of anencephaly among 1,621 obstetrical cases at the Battle Creek Sanitarium, or 1 in every 324 labors (0.3 per cent). Mall (5) estimated the frequency of full-term monsters as 6 in every 1,000 labors. These figures indicate the rather frequent occurrence of monsters in general and of anencephalus in particular.

Williams (6), speaking of monsters, states: "The diagnosis of any one of these conditions is not made until serious difficulty, experienced in attempting delivery, has led to careful exploration under anesthesia, with the entire hand *in utero*."

In rare instances this condition has been diagnosed clinically. Pinzani (8) was able

to recognize the presence of an anencephalon four days antepartum when he was able to detect cerebral contractions following irritation of the brain by the palpating finger. Others suspected, just before delivery, the presence of an anencephalon when the bulging eyeballs, prominent eyelids, and flattened sella turcica were recognized. Hydramnios, the anasarca aspect of the patient, and thickening of the skin of the mons veneris and vicinity have been noted in cases of anencephaly.

Clinical diagnosis is admittedly very difficult. In the early months of pregnancy, vaginal, rectal, or abdominal palpation cannot detect a small deformed head. In the later months, a floating head, malpositions, and perhaps an accompanying hydramnios, leave the examiner confused as to the real situation. Although the presence of hydramnios, which is frequently associated with some fetal abnormality, might lead one to suspect the presence of an anencephalon, it cannot be relied upon as a pathognomonic symptom in individual cases. The incidence of anencephalus with hydramnios has been stated by several observers to be from 8 to 37 per cent. Lau (8) in 75 cases of hydramnios had 9 cases of monsters (12 per cent), 6 of which were anencephalic (8 per cent). He also reports 6 cases of anencephalus without hydramnios. Naujoks (7) had a case of anencephalon with oligohydramnios (500 to 600 c.c.). Eerland (8) had 30 cases of anencephalon, of which only 16 had hydramnios (52 per cent). This indicates the frequent but not constant occurrence of hydramnios with anencephalon. Hydramnios must also be differentiated from multiple pregnancies.

Dystocia is very frequent in these cases

<sup>1</sup>Read before the Bedford Medical Society, May 29, 1930.

because many of the anencephala develop to maturity and malpositions are common. Besides hydramnios, which is present in a large percentage of cases, cardiac and respiratory embarrassment and renal toxicosis frequently complicate the later months of pregnancy. Premature delivery is frequent. When pregnancy does go to term, dry labor is the rule; for the deformed fetal head, being unable to assist in the gradual dilation of the cervix, an early rupture of the membranes results. Abdominal section is not infrequent in unsuspected cases, and, to quote DeLee (1), "the humiliating experience of having a monster delivered after such an operation, has happened to clever accoucheurs." R. J. Maier reported a case of an anencephalon diagnosed pre-natally by X-ray but whose delivery necessitated a cesarean section.

All anencephalic fetuses are born dead or die very shortly after birth. Fetal mortality in all cases of hydramnios varies from 25 to 96 per cent, depending upon the acuteness of the fluid accumulation.

For these reasons it is apparent that when the presence of an anencephalon is suspected the fate of the fetus becomes a negligible factor and only the welfare of the mother should be considered. Anything which would aid in the establishment of an early diagnosis of anencephalon would save the mother the complications of a useless pregnancy going to term.

The roentgen ray has proven to be the only means of establishing such a diagnosis with certainty, pre-natally. Case, in 1916 (10), was the first to diagnose a case of anencephalon by the roentgen ray. Since then other cases have been reported by Campbell and Willits (11), Spangler (12), Doub (13), Rudolph (14), Blanchard (15), Richmond (16), Thompson (17), Andersen (18), Case and Cooper (4), Mooney (19), Maier (9), Harris (20), Jennings (21), Duca (22), Nessa (23), and Naujoks (7).

The causes of anencephaly have been ascribed to heredity, fetal injury *in utero*, poisons circulating in the maternal blood, chemical influence of the salts of sodium, potassium, lithium, and magnesium, syphilis, nutritional disorders, and endocrine disturbances. How these factors influence growth and why deformities of the head should be most frequent have been subjects of extensive investigation.

Normal growth is dependent upon the normal correlation of certain fixed physiologic laws. Any deviation from this normal correlation will result necessarily in *abnormalities of development*, which abnormalities will vary from minute, almost imperceptible deviations from the given type of growth to gross and grotesque variations, according as the disturbing factor has been slight or marked and has functioned early or late in the developmental period of the individual affected. The disturbing element is invariably the action of some extraneous force that has been brought to play upon the delicate regions of the most active growth of the embryonic organism. This extraneous force may be a congenital disease toxin, as of syphilis; a traumatism affecting the ovum in part or as a whole, or some mechanical, actinic, or chemical influence functioning from without the maternal body. If the disturbing force is the same, of the same degree of potency, and is applied at the same stage and point of developmental growth, the same type of monstrous defect will result. These are the general laws of teratogenesis.

There are two main theories that have been advanced in the explanation of the development of monsters, namely, the inhibitory and blastolytic.

Many monsters have been produced experimentally. Chemicals, changes in temperature, X-rays (24) and other agents have been used to influence the growth of embryos. The same type of monstrosity can be repeatedly produced by applying the same





Fig. 1. Roentgenogram of the mother in the lateral prone position showing the full fetal skeleton in the antero-posterior plane. The presentation is cephalic and the head rides above the mother's iliac crests. The facial bones minus the cranial bones give the appearance of a "cat's face." The spina bifida may be recognized by the cleft in the dorsal vertebrae.

dium. Other workers, however, have held that blastolysis is the effect rather than the cause of retardation of growth.

Greenhill (28) and Talbot (29) have called attention to the frequent association of placental defects and anomalies, especially placenta praevia, with deformities of the fetus. Greenhill records 21 such cases. He attributes the defects in the fetus to an imperfect decidual reaction in the lower uterine segment, an abnormal seat for placental attachment and development, and regards it as a condition simulating the imperfect decidual reaction in tubal pregnancy. Disturbances in nutrition and oxygen supply may take place in placenta praevia just as readily as in tubal pregnancy, thereby producing monsters by inducing an arrest of the developmental rate. Talbot believes that placental infarcts are the cause of the circulatory interference within the placenta. The frequency of cranial and intracranial defects in these cases is due undoubtedly to the fact that the central nervous system which received the main portion of the placental circulation is naturally the first portion of the fetal structure to suffer from the vitiated blood current, so, in consequence, a retardation of development results. The head differentiates first and grows most rapidly and therefore is most susceptible to deleterious influences. Anencephalus, he believes, is produced in the beginning of the fourth week of fetal life.

agent at the same stage of development. If the agent is applied to only a part of the embryo, that part alone will be affected. This points to an inhibition or arrest in growth. The experiments of Child (25) and Stockard (26) support this theory.

According to Werber (27), who enunciated the blastolytic theory, monsters are due to the discharge, expulsion, or splitting of the germ substance. In consequence of the destructive action, a lens, for instance, may be found free in the head region of the early embryo even though eyes are entirely lacking; or there may be a complete absence of the spinal cord in its normal position, in which case it may be found in another portion of the embryo or may even be double. For these reasons Werber includes in his theory a force which tends to dissociate parts of the distal embryonic primor-

To determine the influence of endocrines in the production of anencephaly, Covell (30) made an exhaustive study of the hypophysis in 37 cases of anencephaly. He found it present in all cases, contrary to the findings of some previous investigators. It was flatter and its anterior lobe was larger than the hypophysis in normal fetuses; but after correcting for the blood content of the gland, he found that the hypophysis was quantitatively smaller than normal in every case of anencephalon. The normal gland has three lobes and a pars tuberalis. The latter



Fig 2. Photograph of the anencephalic monster after delivery. Note the macerated skin, bulging eyelids, and absence of forehead.



Fig. 3. Dorsal view of the same fetus showing extensive spina bifida. Note the very short and thick neck.

lobe was absent in all cases he studied, although some other lobes were missing in some of the cases.

#### CASE REPORT

Mrs. O. J., 34-year-old primipara, was referred for roentgen examination on January 5, 1929, in the eighth month of her pregnancy. She was dyspneic and her abdomen was unusually large. Her pregnancy had been normal up to six and a half months, after which time the abdomen began to increase rapidly in size, the fetal parts became indistinguishable, and the fetal heart sounds (previously audible) were gradually lost. Her blood pressure gradually rose to 160 mm.; the blood Wassermann was negative.

Roentgen examination in the lateral prone posture showed the presence of a fetal skeleton of cephalic presentation and above

the crest of the ilium. The bones of the face were distinctly visible but the cranial bones were absent. The thoracic vertebrae were unusually wide and there was a cleft in the middle of the column due to the absence of the spinous processes. The rest of the skeleton was apparently normal. A diagnosis of anencephalon with spina bifida was made and immediate interruption of pregnancy advised. Because of religious beliefs, the patient refused intervention.

In spite of treatment the abdomen became larger and the patient's blood pressure gradually rose to 190 millimeters. Four weeks later, February 4, 1929, the membranes ruptured and after eighteen hours in labor she was delivered of an anencephalon weighing  $6\frac{1}{4}$  pounds. Four mild convulsions preceded the delivery. The postpartum period was uneventful. The fetus showed all of the characteristics of an encephalon. The entire vault was missing. The eyelids were un-

usually large, and there was a spina bifida extending from the base of the skull half way down the back. The skin in many places was macerated.

### CONCLUSION

Cases of anencephaly and their resulting complications are of sufficient frequency to warrant greater accuracy in our diagnostic methods. Any pregnant woman giving a history of having previously given birth to a monster; one presenting an acute or unusual enlargement of the abdomen, or a fetal malposition or malposition of the placenta; one upon whom a cesarean section is contemplated, or one in whom the fetal head is not distinctly and apparently normal to the palpating fingers should have an X-ray examination of the abdomen. The cranial bones begin to ossify between the sixth and eighth week of fetal life and calcification is well advanced after the fourth month. Satisfactory roentgenograms can be obtained after the fourth month in a great majority of cases, but obviously the difficulty increases with the increase in the amount of amniotic fluid and the thickness of the abdominal wall. Practically all fetal skeletons are visible at the sixth month. Maternal complications rarely set in before the sixth month of pregnancy. Therefore, the optimum period for the roentgen examination of the pregnant abdomen is at about the sixth month of pregnancy. The small amount of X-ray energy utilized in modern technic is absolutely harmless to mother or fetus.

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# THE TREATMENT OF WARTS<sup>1</sup>

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THE treatment of warts is a subject of widespread interest and demands a great deal of our time and consideration. It is common knowledge among dermatologists and other physicians examining large numbers of college students, both male and female, that the last ten years have seen a steady increase in the number of warts, particularly on the feet. This opinion is substantiated by the authors' statistics. We have examined and treated 765 patients with all types of warts within the past three years, equivalent to approximately from 5 to 6 per cent of the total number of cases seen in private practice. Prior to 1925, this figure did not exceed 3 per cent. Most of this increase in the incidence of warts has occurred in the class of plantar warts. The reasons for this are obvious. The wide popularity of all forms of sports requiring the common use of dressing rooms, shower baths, runways, etc., has increased the probability of infection. From our experience we are convinced of the infectious nature of ordinary verrucæ vulgaris, and verrucæ plantaris, which we feel are one and the same entity occurring upon different parts of the body. We feel that the work of Jadassohn (1), in 1896, and of Wile and Kingery (2), in 1919, has settled the infectious nature of warts with fair definiteness.

Table I shows the incidence of location in our 765 patients. It will be noted that our total number of patients with plantar warts outnumbers considerably the patients with warts on the hands. This, no doubt, is due to the fact that plantar warts produce symptoms whereas warts on the hands usually do not, and not to any actual increase in the number of plantar warts over the

TABLE I.—INCIDENCE OF LOCATION OF WARTS

|   | No. | Per cent |
|---|-----|----------|
| Plantar .....   | 322 | 40.6     |
| Hands .....   | 248 | 31.3     |
| Face .....  | 149 | 18.7     |
| Neck .....  | 22  | 2.8      |
| Scalp .....   | 27  | 3.4      |
| Arms and wrists .....   | 7   | .9       |
| Penis .....   | 5   | .6       |
| Miscellaneous (vulvæ, ears, perianal region, knee, chest, etc.) ..... | 12  | 1.6      |
| Total .....   | 792 |          |

other type. Thirty-three patients presented warts on both the hands and feet, and 37 patients had warts both on the hands and face.

As to age incidence, we have patients presenting warts of one form or another from the age of 8 months up to 81 years. By far the vast majority of patients were between the ages of 10 and 40, with the number about even in the second and third decades of life, and somewhat less in the fourth decade. Approximately 40 per cent were females, 60 per cent males.

## THE TREATMENT OF PLANTAR WARTS

The treatment of plantar warts comprises one of the most important and difficult fields presented to the dermatologist and radiologist. The importance of plantar warts from an economic standpoint cannot be overemphasized. It is true that many plantar warts occasion no symptoms, but the vast majority of them cause symptoms ranging from pain and discomfort on walking, to actual confinement in bed.

The diagnosis of plantar warts usually does not occasion much difficulty; however, there is much to learn by careful clinical observation and study of each individual wart. It is easy enough to recognize a wart on the sole when it has reached the diameter

<sup>1</sup>Read before the Radiological Society of North America at the Fifteenth Annual Meeting, at Toronto, Ont., Canada, Dec. 2-6, 1929.

of a sixteenth of an inch, but frequently the small, pinhead-size satellite lesions are entirely overlooked. It is only by carefully paring down the area with a sharp razor blade that one can recognize these small lesions. The authors have found it advantageous to use a lens in the identification of these very minute, early warts. Calluses and corns are frequently mistaken for plantar warts; especially is this true of painful lesions occurring in the last interdigital space. These lesions occur more commonly in women than in men, and are located either at the base of the interdigital space between the fourth and fifth toes, or on the inner side of the small toe, and most frequently in both locations at the same time. Careful observation has convinced us that these lesions are usually not warts, but calluses produced by pressure. When the small toe is pressed inward by the pressure of a shoe, the inner surface of the small toe is pressed against the external or lateral tip of the fourth metatarsal bone. Spreading the toes apart and causing pressure on this point will produce the characteristic pain even when the calloused area is pushed aside and the pressure made through normal skin. We have never seen one of these lesions cured with X-ray or radium therapy, and we have seen a great many patients with such lesions made extremely miserable by this form of treatment. These lesions are best treated by changing the type of footwear, spreading the toes with a small soft cotton pad, and the application nightly of a mild keratolytic ointment. When the pressure is removed from the tip of the fourth metatarsal bone for a period of from six to ten weeks, the pain usually disappears.

Plantar warts vary in size from the minutest, which cannot be seen by the naked eye, to lesions as large as a 50-cent piece. Ordinarily, when recognized they are one-sixteenth to one-quarter of an inch in diameter. Satellites are frequently present, and search should always be made for them.

The number varies from one lesion up to as many as three or four hundred on a foot. The wart is covered by a layer of keratotic material, the thickness depending upon the location, and proportional to the normal thickness of the horny layer of the part involved. On paring off the horny layer with a sharp razor blade, the translucent wart is seen embedded in the normal tissue. It may be larger or smaller, more frequently the latter, than it appeared before the horny layer was removed. After paring, brownish-black dots will be seen in the center of the wart. These are capillary loops which bleed profusely if cut. These brownish-black dots can always be seen except in the minutest wart, and, if bleeding occurs, it is a sign that the wart is still active and needs further treatment. The pain, of course, is the chief symptom of plantar warts. It may be totally absent in the case of a superficial, small lesion, but it may be so excruciating as to cause permanent disability for long periods of time. We have a number of patients who have been totally incapacitated, and confined to bed for periods of from six months to a year and a half on account of injudicious treatment, and a large number who have been partially incapacitated for long periods of time, with or without treatment.

We have gradually evolved what we feel is a thoroughly satisfactory technic for the treatment of plantar warts. It differs somewhat from the technic employed by others, including Michael (3), Taussig and Miller (4), MacKee (5), and Hazen (6). In the first place, we have practically discontinued the use of radium. The reasons for this are as follows:

1. The time required for the treatment of plantar warts with radium is considerably longer than that required for X-ray treatment.

2. When multiple warts are present, either a large amount of radium must be on hand, or else a number of separate applica-

tions with the same radium must be made on subsequent visits.

3. In spite of all the care possible, occasionally the patient will move his foot or contract his muscles in such a way as to disturb the lead foil and the radium. In this case a disagreeable result is apt to ensue, because the dose of radiation which would not produce any reaction when applied directly to the wart, will produce considerable reaction to the normal skin, and the patient is very quick to notice this.

4. Radium in plaque form with two thicknesses of rubber, with or without 0.5 mm. of aluminum, will produce considerably more reaction in the normal skin surrounding the wart than will approximately the same dose of X-ray. The authors have repeatedly demonstrated this fact to their own satisfaction, and it can readily be understood when one considers the difference in the distance from the source of radiation to the skin. With X-ray, one is dealing with parallel rays, practically speaking, while with radium applied closely to the skin, the radiation is spread out into the surrounding normal tissue, and the reaction ensues. We have treated one plantar wart with radium, and an adjacent wart on the same foot with approximately the same dose of X-ray. Reaction has occurred around the radium-treated wart, and the X-ray-treated wart showed no surrounding reaction.

Our technic for the treatment of plantar warts with X-ray is as follows:

1. The patient is placed on a high examining table, and the keratotic layer over the wart and for some distance around it is carefully pared down with a new razor blade, to a point just short of bleeding. We feel that careful attention to this one factor has increased our percentage of cures at least 20 per cent. Careful search should be made for small satellites which cannot be seen unless the keratotic layer is pared

down, and these lesions should be treated at the same time.

2. After locating all of the lesions they are carefully outlined with a fine-pointed pen exactly at the periphery of the wart. Placing a sheet of thin oiled silk over the area on the foot, a careful tracing is made of the lesions. This tracing is then transferred to lead foil and the holes are cut out accurately with a sharp, fine scissors.

3. The patient is then placed on his abdomen or side, and the foot held in a stirrup which will not move, being so fastened as to give as much stability as possible to the entire leg. It is absolutely essential that the patient be under no muscular strain while the treatment is going on. The lead foil is then fitted exactly to the wart area, and fastened down by adhesive straps which go entirely around the foot. We feel that this is the most essential part of the entire process, and that the lead foil must fit exactly to the wart areas without exposing any normal tissue to the effect of the X-ray. We have found that nurses can be trained to do this work much better than doctors, and that they will take infinite pains to get the lead foil exactly in the right position. It requires time and patience on the part of the nurse, but the results justify the time. After instituting this procedure, we soon found that no reaction occurred in the normal tissue surrounding the wart, with our ordinary dosage of from 2 to 3 skin units of X-ray. We have gradually increased this dosage until we have reached 8 skin units, with absolutely no visible reaction in the normal tissue in a vast majority of cases, and only a slight erythema in those that did react. We have not had in the past three years, since following this technic, a single disagreeable reaction from X-ray.

4. In treating with X-ray, we have employed the following factors: 6-inch spark gap, 6 milliamperes, and an 8-inch distance from cathode to skin.

During the past three years we have entirely discarded the fractional, repeated doses of X-ray to plantar warts. Our percentage of cures has risen 20 per cent since employing the single, massive dose. We have never repeated the dose inside of two months, and we have seen warts disappear ten weeks after the one initial, maximum dose. We have never given more than two maximum doses to a single wart.

Out of a total of 322 patients with plantar warts, 220 were treated with X-ray, and the result noted. Of these, 176 were cured with one treatment, or a percentage of 80; 17 patients were cured with two X-ray treatments, or a percentage of 7.7, giving a total percentage of 87.7 cured by X-ray alone. Thirteen patients were not cured by X-ray, and were later operated on with electrocoagulation, all of them being cured. Five patients were not cured by electrocoagulation, but were cured with X-ray following. Thirty-nine patients were cured with electrocoagulation alone. Five patients required two operations with electrocoagulation, before they were cured. During the past three years only six patients have been treated with radium, with three failures, due to the fact that they were unusually difficult cases. These three failures were later cured by electrocoagulation. Nine patients out of a total of 220 that we have been able to follow have not been cured by any method which we have employed. An analysis of our failures shows the following facts:

1. It is foolhardy and dangerous to attempt to cure a plantar wart with radiation, if it does not respond to one or two maximum doses.

2. Some warts are resistant to radiation, and although a mild reaction takes place from treatment the warts persist. These lesions should not be treated further.

3. It is well to note the condition of the peripheral arterial circulation before treating a plantar wart. Most of our failures have been in patients in whom the peripheral

arteries have been damaged either from arteriosclerosis, Buerger's disease, diabetes, or trophic disturbances from neurosyphilis. We have made a firm rule never to treat more than once a plantar wart occurring in an individual with damaged peripheral circulation, and if no result is secured, operative procedures are recommended.

4. It is unwise to further radiate a lesion that has been radiated elsewhere, unless the exact dose given is known.

Thirty patients out of a total of 44 who were cured by electrocoagulation, had received previous radiation treatment elsewhere, and all were suffering from the effects of overradiation. Anyone who has observed the extreme suffering to which these patients are subjected for months, and even years, cannot help but feel the tremendous responsibility in treating plantar warts with radiation therapy. We firmly believe that it is a mistake to promise cure of a plantar wart with radiation therapy, and then of necessity continue the treatment to the point of a severe reaction. It is much better to give the patient an exact percentage chance of cure, and if one or two treatments fail, remove the lesion with the high frequency current in one form or another. When over ten or fifteen warts are present, they are best removed by electrothermic means. Ten of our patients had over fifty warts on one or both feet. The warts were first coagulated or dissected as thoroughly as possible, and then the lesion was curetted out and the base treated again until all the spongy wart tissue was destroyed. These lesions usually require confinement to bed for from a week to two months, depending upon their size and the previous radiation therapy.

The treatment of warts on the hands is a problem somewhat different from the treatment of plantar warts. In general, the horny layer is not so thick, and the lesions occasion very little or no pain. When the lesions are multiple, we believe that the best



method of treatment is the destruction with electrodesiccation or electrocoagulation. Isolated lesions that can be very carefully trimmed down and outlined with lead foil, can be treated with X-ray. We have employed one massive dose to better advantage than repeated fractional doses. Our dose has varied from 2 to 6 skin units, depending upon the depth of the lesion. Out of a total of 248 patients with warts on the hands, 88 were treated by X-ray; 64 (or 72 per cent) were cured with one treatment; 7 were cured with two treatments, giving a total of 84 per cent cured with X-ray. Those not cured with X-ray were later cured with electrodesiccation.

Warts occurring elsewhere on the body than hands and feet have all been treated with the high frequency current, either in the form of electrodesiccation or electrocoagulation. Our results have been uniformly satisfactory, and with experience one becomes very proficient in destroying warts on the face, with a minimum of scarring. The infectious nature of these warts should never be overlooked, nor the fact that the incubation period is from four to seven weeks. For this reason we should not be content to destroy the lesions present at the time, but should examine the patient at intervals of from one to two weeks, for several months before discharging him as cured. This is especially true of warts on the face and neck of male adults. Shaving is the chief cause of spread in these cases, and care should be taken by the patient not to shave close.

The treatment of warts of various types with sulpharsphenamine intramuscularly has occasioned considerable interest, since the report by Sutton (7) of the treatment of six cases successfully by this means. He recommends its use, particularly in the juvenile type of warts on the hands. We have treated 45 patients of all ages with sulpharsphenamine, using as high as five doses. There were 20 cures, and 20 failures. Five

patients were untraced. Nine patients were cured with one dose, 5 patients with two doses, 2 patients with three doses, 2 with four doses, and 2 with five doses. Of those that were not cured, 11 received one dose, 7 received two doses, and 2 received three doses. We have used sulpharsphenamine particularly in patients presenting a large number of warts on the face, neck, and hands, with the idea that the patients presented a difficult therapeutic problem, and if they did respond to sulpharsphenamine, it would be a fine achievement, whereas if they did not, nothing would be lost and the lesions later could be destroyed by other means. Our results have been better in individuals past the age of puberty. We feel that sulpharsphenamine has a place in the treatment of these difficult cases, but that it should not be used indiscriminately.

#### CONCLUSIONS

1. The diagnosis and treatment of plantar warts is a subject demanding much care and consideration on the part of the physician.
2. The infectious nature of warts should always be borne in mind.
3. We believe that X-ray is preferable to radium in the treatment of warts.
4. We believe that one massive dose is preferable to the fractional dose method.
5. The essentials of the X-ray treatment of plantar warts should consist of (a) careful paring off of the keratotic covering, (b) careful approximation of lead foil to the exact periphery of the wart, (c) rigidity of the foot during the treatment, (d) when normal tissue is not exposed to the X-ray, the total dose can be as high as 8 skin units.
6. The percentage of plantar warts cured with one treatment was 80 per cent; with two treatments, 7.7 per cent, giving a total percentage of 87.7 per cent cured by X-ray alone.
7. If plantar warts do not respond to

one or two maximum doses of X-ray, they should be destroyed thoroughly by electrothermic means.

8. Attention should be paid to the peripheral vascular condition. Failures occur more commonly in patients with damaged vasculature.

9. Electrodesiccation and electrocoagulation are the methods of choice in the treatment of the majority of patients with warts on the hands, face, neck, genitalia, and general body surface. Isolated warts on the hands can be treated with X-ray, using the same technic as in plantar warts, with smaller dosage.

10. Sulpharsphenamine should be judi-

ciously used in the treatment of extensive warts on the hands, face, neck, and elsewhere.

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# CONSTANT TEMPERATURE FOR X-RAY DEVELOPING

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**D**IAGNOSTICIANS are now reading shadows on X-ray negatives the existence of which was unsuspected even a few years ago. Progress in this field has been followed but slowly by better dark room technic, not because dark room people are less skillful, but because refrigeration manufacturers and designers have been slow to accept the challenge of a somewhat undeveloped market, and the importance of the dark room as a factor in beautiful technical work has been underestimated. It is the purpose of this paper to present a design for a developing tank which will hold the water flow and temperature within far closer limits than has heretofore been the practice, and thus permit exact control of the developing process.

With equipment of this type, the technician merely leaves the films in the developer for five minutes, removes them for a rinse, leaves them in the hypo for ten minutes, puts them through a double wash, and the job is ready for the dryer. He needs to watch nothing but time, and the alarm clocks to be had have already made that almost automatic. "Eye development," which has spoiled more good negatives than ever worn-out hypo has, is never necessary.

## TANKS

The set-up is shown diagrammatically in Figure 1, with a sealed unit type refrigerating machine at the end of a typical tank arrangement, with the films progressing logically from left to right. The tap water gets its initial temperature drop in the pre-cooler (of which more later), going then to the weir float control, and enters the main tank just to the left of the chilling unit.

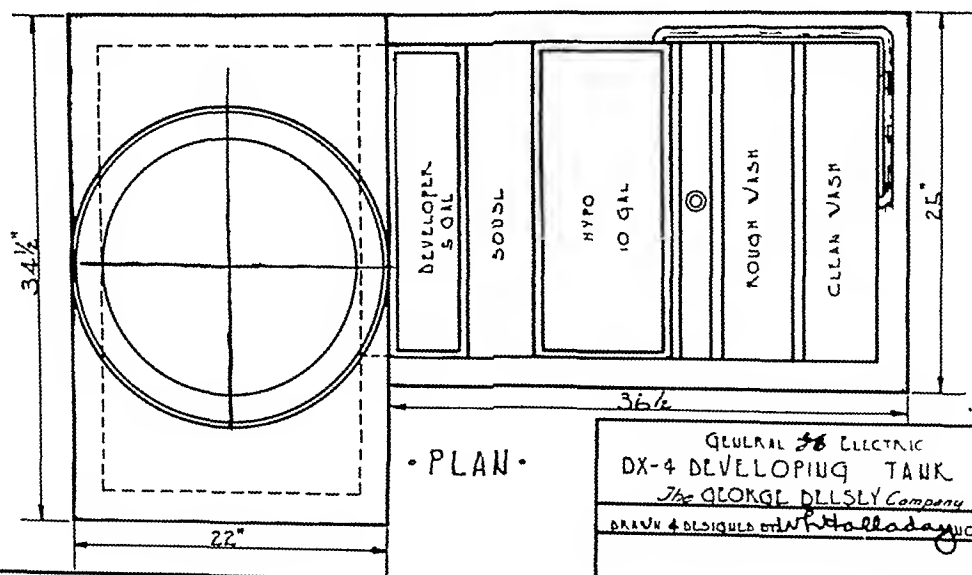
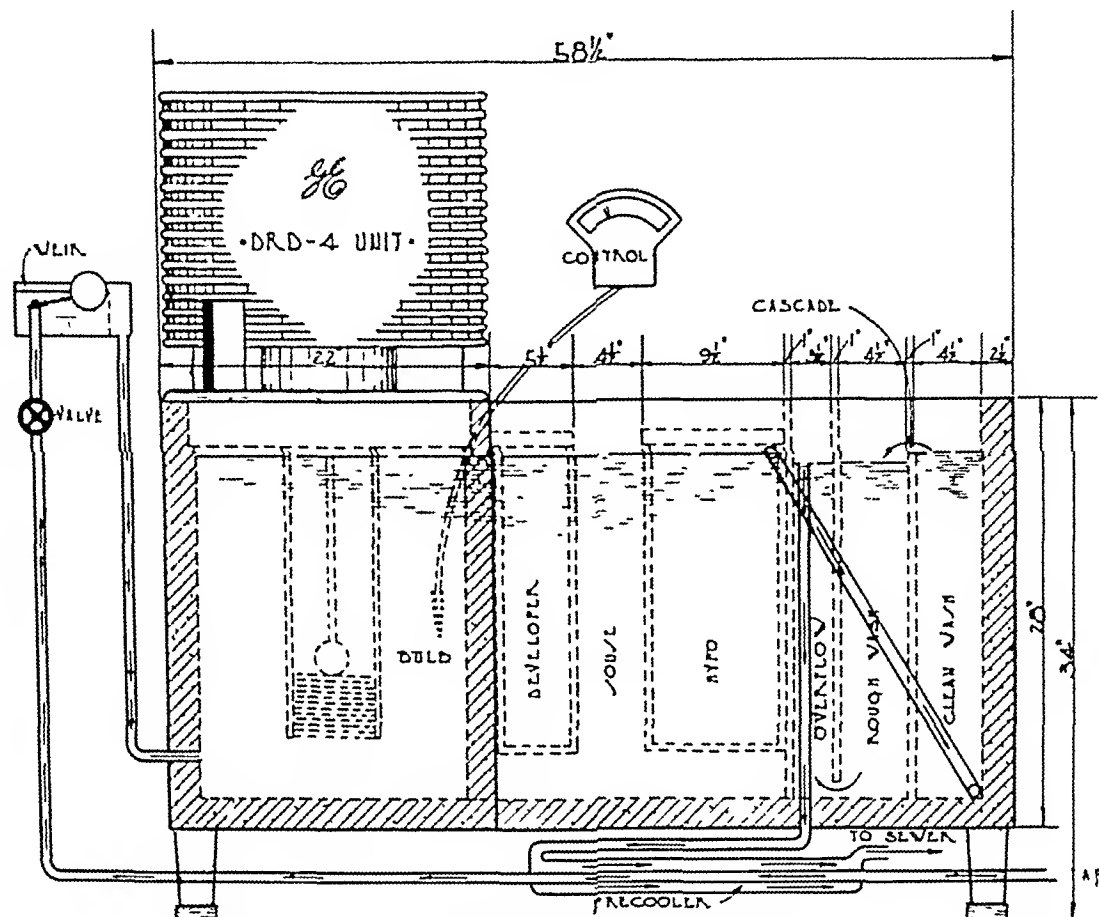
Having been further cooled at this point, the water flows past the helical sensitive bulb of an accurate electrical control, which will turn on and off the motor of the refrigerating machine upon a plus or minus half-degree variation in water temperature. This water, with its temperature so accurately maintained, then flows around the developer inset, progressing through the rinse compartment, around the hypo inset, detouring to the second or "sweet water" wash, then to the rough wash, and out to the pre-cooler.

The developer tank is a standard five-gallon size, which will hold six or seven films. Since the films should stay in the hypo ten minutes, the hypo inset is the ten-gallon size and will take from 12 to 14 films. The souse between the two is as wide as the developer inset.

The washing arrangement is the well known Eastman "double wash," described in their *X-ray Bulletin*, August, 1929. Two tanks of equal size are provided, the first (through which the water flows *last*) for rough wash and the second for sweet water wash. The down-flowing water in the rough wash more efficiently removes the hypo, while in the rinse tank, with most of the hypo gone, the direction of water flow is unimportant.<sup>1</sup>

Each of the wash tanks is of nine gallons capacity, a size which easily takes seven films. It has been found that a total washing time of 15 minutes gives acceptable results if the water flow per hour is four times the volume of the wash compartment. In order to take care of overloads and other conditions imposing unusual demands on

<sup>1</sup>Permanganate tests with this type of tank at the Los Angeles General Hospital have shown the sweet water wash to be completely hypo-free.



$$\frac{d t}{d(T_2 - t_1)} = \frac{1}{1/(T_2 - t_1)} = T_2 - t_1.$$

This is a mathematical statement that as the loss in temperature of the cooled water approaches the gain of temperature of the cooling water, the mean temperature difference approaches  $(T_2 - t_1)$ , which is the arithmetical difference between the initial temperature of the cooling water and the

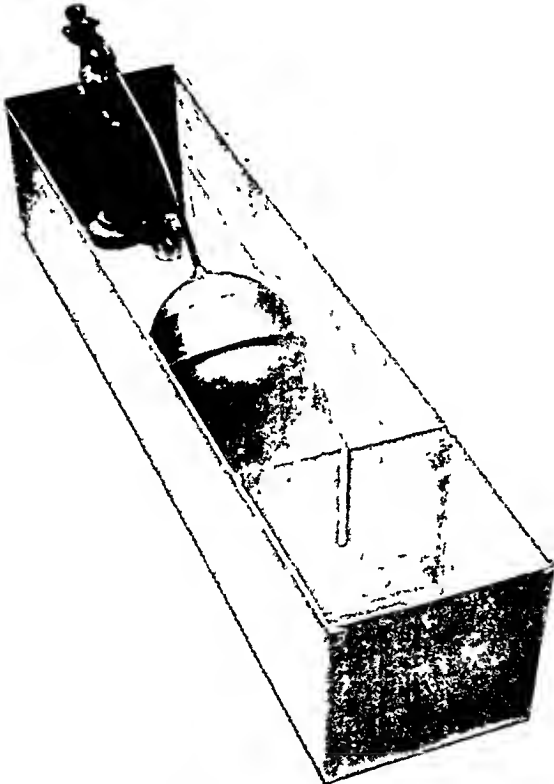


Fig 3 Weir flow control.

final temperature of the cooled water. In general, good pre-cooler design should bring this mean temperature difference down to two degrees.

Solving equations (1) and (2) for  $S$ , we have

$$S = \frac{(T_1 - T_2) Q D}{U \Delta t} \quad (5)$$

Tests have indicated that with a developer temperature of 65 degrees, there may under unfavorable conditions be a rise of two degrees through the wash tanks, bringing the outflowing or contaminated water to 67 de-

grees. Since the mean temperature difference in the precooler is to be two degrees, it will be assumed that the precooler will bring the tap water to 69 degrees.

Let  $T_1$  be 90 degrees,  $T_2$  be 69 degrees,  $Q$  be 50 gallons per hour, assume  $U$  to be 30 for galvanized iron pipe, and  $\Delta t$  be 2 degrees, then

$$S = \frac{(90 - 69) 50 8.35}{30 \cdot 2} = 146 \text{ square feet.}$$

The equation is diagrammatically solved on the chart, Figure 2, where the surface may be obtained if the tap water temperature, water flow, and desired mean temperature difference are known. Drop vertically from the tap water temperature figure to the intersection of the diagonal flow line, go horizontally to the intersection of the temperature difference line, then read the result as surface in square feet. These surface figures are based on a constant for standard iron pipe of 30; for copper or brass, multiply by 0.67; for block tin, multiply by 0.50.<sup>2</sup>

#### FLOW CONTROL

The weir is a well-known means of measuring water flow in an open channel. It is a special form of orifice, a constriction in the area of the channel so that the water must flow over an obstruction. The height of the water above the obstruction, or base of the weir, is called the head, and is a definite measure of the flow. In a rectangular weir the quantity of water flowing varies as the three-halves power of the head. It is easy, then, by holding the head constant, to hold a constant flow. The head can be kept at one value by an ordinary "low tank" water closet float and valve. Such an as-

<sup>2</sup>The writer recognizes that heat transfer through pipe walls is an extremely variable thing, dependent upon thickness, size, shape, and cleanliness of the tubes, water velocity, amount of entrained air, and other factors, and may under particularly favorable circumstances run twice as high as calculated. Nevertheless, in X ray pre coolers,  $U$  will generally vary from 30 to 60, the better conducting metals giving the higher values.

ssembly, with a weir of one-eighth inch width, is shown in Figure 3.

The heads of a one-eighth inch weir, corresponding to various water flows, are:

| Water Flow<br>Gallons per Hour | Head in Inches<br>above Base of Weir |
|--------------------------------|--------------------------------------|
| 10                             | .58                                  |
| 20                             | .92                                  |
| 30                             | 1.21                                 |
| 40                             | 1.46                                 |
| 50                             | 1.70                                 |
| 60                             | 1.91                                 |
| 70                             | 2.13                                 |

The use of a weir float control makes fussing with a manual valve unnecessary—when the tank is put into use, the water is turned on full force; the weir will attain its head and hold the flow for which it is set. The weir should be by-passed with a manually operated valve, which is normally closed, but which may be opened so the tank may be rapidly filled after cleaning.

#### TEMPERATURE CONTROL

The electrical control has its sensitive bulb placed half-way between the chilling unit of the refrigerating machine and the developer inset. In conducting the tests upon which this article is based, a Bristol Model 177 thermostat, with a 50–80 degree range and a special helical bulb, was used. Set to a differential of plus or minus one-half degree, its control of motor operation was so sensitive and accurate that for a three-day period, half the time with the wash water not flowing, the total variation in temperature at the center of the developer was 0.2 degree.

This thermostat (with its necessary relay) should operate to turn on and off the motor of the refrigerating machine. In localities where the winter tap water temperatures drop below 65 degrees, a reversing switch can be placed in the control circuit so that the thermostat will operate a 200-watt heater mounted in the bottom of the tank,

under the chilling unit. If the tap water temperature undergoes great variation at frequent intervals, an additional thermostat could be placed in the tap water line, set to reverse the main control to the heater if the temperature be below 64 degrees, and to connect it to the refrigerating unit upon the resumption of higher temperatures.

#### REFRIGERATING UNIT

It has been said that a properly designed precooler should bring the tap water down to 69 degrees. The job of the refrigerating unit is, then, to drop it the other four degrees—to 65.

This, at a flow of 50 gallons per hour, represents a load of  $4 \times 50 \times 8.35 = 1,670$  B.t.u.'s per hour.

Wall leakage in an 80-degree room will amount to about 250 B.t.u.'s per hour, so there is a total load of about 1,900 B.t.u.'s per hour. The refrigerating machine should then have a capacity 40 or 50 per cent greater than this, so that its running time will not be excessive and some factor of safety is left for hot weather conditions.

The machine used for the tests has the following specifications:

|            |   |
|------------|---|
| Motor      | ½ Hp., 220 volt, single phase. Power input 570 watts. Power factor 80–85 per cent.                        |
| Compressor | Twin oscillating cylinder type, direct connected to motor. Force feed oiling system. Hermetically sealed. |
| Condenser  | Multiple, air cooled by natural circulation.  |
| Evaporator | Cadmium plated copper, designed for water immersion.  |
| Capacity   | 2,800 B.t.u.'s per hour, 80 degree room, 65 degree bath.  |

#### REMOTE COOLING

A word might be said about the type of design employing a remote electrically re-

refrigerated water cooler, set to hold approximately 65 degrees and furnishing a constant flow of water as near this temperature as possible. In general, the writer's experience has been that this installation is not as satisfactory as that which this paper describes; there is an inevitable lag in temperature from the water cooler to the developing tank, giving rise to greater variations in temperature than should be permissible in an automatic device. After all, it is not enough merely to cool the water, or that the control be sensitive. The control must be properly placed near the point where the constant temperature is needed (in other words, near the developer inset); it must be accurate as well as sensitive. Remotely controlled cooling of water brings many variables into the problem: the room temperature's effect upon the heat leakage of the pipe leading from the cooler to the developing tank, upon the heat leakage of the tank itself: the heating effect of increased service upon the tanks (the cooling of hangers and films): the cooling effect of evaporation from the surface of the wash water, variable with bath and room temperatures, and relative humidity, and the slight heating effect of the developing and fixing reactions themselves, all of which are automatically compensated for by having the chilling unit and sensitive control bulb in the wash water surrounding the insets.

#### APPLICATION

In general, this type of tank is applicable to all locations where the tap water goes above 70 or 72 degrees. It is generally accepted that present type X-ray films should not be washed in water warmer than 72 degrees. If the water be colder than that the year round, a much simpler set-up is possible, with a very small flow (of the order of one gallon per hour) merely surrounding the developer inset, the washing being done in tap water. No precooling is necessary, and the refrigerating requirements may be handled by a tap from a refrigerated drinking fountain, with the accurate temperature controlled by a thermostatically operated heater or a Fulton syphon regulator. Emphasis must be placed upon the fact that this type of equipment is not satisfactory if the tap water is liable at any time to go above 72.

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# THE "QUALITY" OF AN X-RAY TUBE AND HOW TO MEASURE IT

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From Natuurkundig Laboratorium der N. V. Philips Gloeilampenfabrieken

IN earlier papers the writer has described some investigations on the temperature rise of the anode of an X-ray tube and its load-carrying capacity and on the size and shape of the focal spot.<sup>1</sup>

Some of the conclusions are:

1. An anode of copper provided with a thin tungsten target may carry a load of 200 watts per sq. mm. for one second. A much larger load would result in too high a temperature and consequently in evaporation or melting of tungsten or copper.

2. The best type of focus is the line focus, with the X-ray beam at an angle of about 20° to the surface. Such a line focus carries a load which is one and a half to two times larger than that carried by a circular focus of equal area.

3. The size of the focal area is far less important than the type of focus and its load-carrying capacity per unit area or "specific capacity." For a given sharpness of definition, a large focus requires a longer distance, and, as the energy required for a given exposure time and the area of the focal spot are both proportional to the square of the distance, the required increase of load is exactly what the enlarged focal area will allow it to carry.

## DEFINITION OF "QUALITY"

As far back as 1925 it was suggested by Franke<sup>2</sup> that the relation between the load-carrying capacity during one second and the focal area be called the "specific capacity"

<sup>1</sup>Ueber den Temperaturverlauf an der Anode einer Röntgenröhre. Ztschr. f. techn. Physik, 1927, VIII, 271.

Der Brennfleck einer Röntgenröhre und die Belastbarkeit. Fortschr. a. d. Geb. d. Röntgenstr., 1929, XL, 284. Abstracted in Am. Jour. Roentgenol. and Rad. Ther., 1930, XXIII, 460.

<sup>2</sup>H. Franke, Brennfleck und Bildgebung. Verhandl. Deutsch. Röntgen-Gesellsch., 1925, XVI.

or "Güte" of an X-ray tube. It is not, however, the real area of the focal spot that matters so much, but the area of the "effective focus," the projection of the focal spot in the direction of the radiation. The "effective focus" depends upon the angle of the rays with the anode surface, or, in other words, on the type of focus used. The relation between the load-carrying capacity and the area of the "effective focus" determines the sharpness of definition attained in a given exposure time. We shall, therefore, in this paper call the quotient of the load-carrying capacity during one second and the area of the "effective focus" the "radiographic quality," or briefly, the "quality" of the tube.

$$Q = \frac{w}{f} \frac{\text{K.W.}}{\text{mm.}^2}$$

( $w$  = load-carrying capacity during one second in K.W.,  $f$  = effective focal area as measured by a pin-hole camera, *vis.*, the real area of the focal spot multiplied by  $\sin. \varphi$ , if  $\varphi$  is the angle between the beam of radiation and the focal surface.)

The "quality" of a good tube is

$$\frac{0.2}{\sin. \varphi}$$

as 0.2 is the "specific capacity," according to the first conclusion (see above).

We shall first consider the "central ray." This is in the direction perpendicular to the axis of the tube, making an angle of 20° with the anode surface in the case of the line focus and of 45° in the case of a circular focus. We are well aware that it is not only the "central ray" that is of interest, but we shall see later on how far our conclusions will have to be altered if we take into consideration the deviations



from the central direction, as they occur in practice.

For an angle of  $20^\circ$  with the anode surface the projection amounts to one-third of the actual area, as

$$\sin. 20^\circ = \frac{1}{3}.$$

For an angle of  $45^\circ$ , as in the case of a circular focus, the effective focus is roughly 0.7 of the actual area. Therefore the "quality" of a good line focus tube should be

$$Q = \frac{0.2}{\frac{1}{3}} = 0.6$$

and of a circular focus tube

$$Q = \frac{0.2}{0.7} = 0.28.$$

#### MEASUREMENT OF "QUALITY"

To determine the "quality" ( $Q$ ) of a given X-ray tube it would be necessary and sufficient to measure the load-carrying capacity,  $w$ , and the size of the "effective focus." The latter is the easier, as it is sufficient to take a simple pin-hole picture in the direction of the radiation.

Not so easy, however, is the determination of the load-carrying capacity of a given tube. One could, of course, try experimentally what a tube can stand, but then the desired knowledge would be acquired only by sacrificing the tube itself. A better method would be to measure the load which heats the anode to a previously determined "safe temperature," say 2,600 degrees.

The method which will be described now is much simpler, however, and involves much less danger for the tube. It is the method used successfully by the writer and his collaborators during many years of laboratory practice, as well as in the manufacture of many thousands of Metalix tubes. The principle is as follows:

The temperature of the target at the end of the load is directly proportional to the

applied energy, as proved by calculation.<sup>3</sup> Instead of applying a heavy load and measuring the temperature to find which load heats the anode exactly to the admissible temperature, say 2,600°, we apply only such a load that the temperature at the end of one second is half the permissible temperature, viz., 1,300 degrees. The number of watts necessary to obtain this temperature is then 50 per cent of the total load-carrying capacity. By this method the tube is not at all in danger and there is a high degree of accuracy in the measurement. For a temperature of about 1,250°, the emission of light varies rapidly with the temperature. Experimentation shows that at about 1,250° the focal spot begins to glow slightly, that is to say, with the tube filament heated: it would probably glow at a much lower temperature if it were in complete darkness. The glow becomes quite distinct at 1,300°, and without much experience one can always tell with certainty whether the temperature is below 1,250° or above 1,300 degrees. Figure 1 clearly shows how a difference in brilliancy of, say, 50 per cent, means only a very little difference in temperature. This is the reason why the measurement can be made in an exact way. It is not even necessary to take the temperature after exactly one second, for the temperature rise after half a second is so very slow that a difference of half a second would have little effect. This is made clear by Figure 2, which shows the temperature rise in the first second and a half.

To see the focal spot it is, of course, necessary to adjust a small mirror in front of the aperture, or, if one looks directly into the tube, to apply at least one cm. of good lead glass.

The determination of the number of watts is easily done by taking always a constant voltage of 50,000 and by increasing the milliamperage until the focal spot shows

<sup>3</sup>A. Bouwers, Ueber den Temperaturverlauf an der Anode einer Röntgenröhre. Ztschr. f. techn. Physik, 1927, VIII 271.

its red glow. Say, for example, that we find 60 ma., then we know that

$$\frac{w}{2} = 50 \times 60 \text{ watts} = 3 \text{ K.W.}$$

or

$$w = 6 \text{ K.W.}$$

In other words, that the tube in question is a 6 kilowatt tube. It is necessary to be

per cent, without exact measurement of the temperature and simply by looking at the anode.

The method described above tells immediately how many kilowatts a tube will stand, *viz.*, 0.1 part of the milliamperage found, provided, of course, that the applied voltage was actually 50 kilovolts.

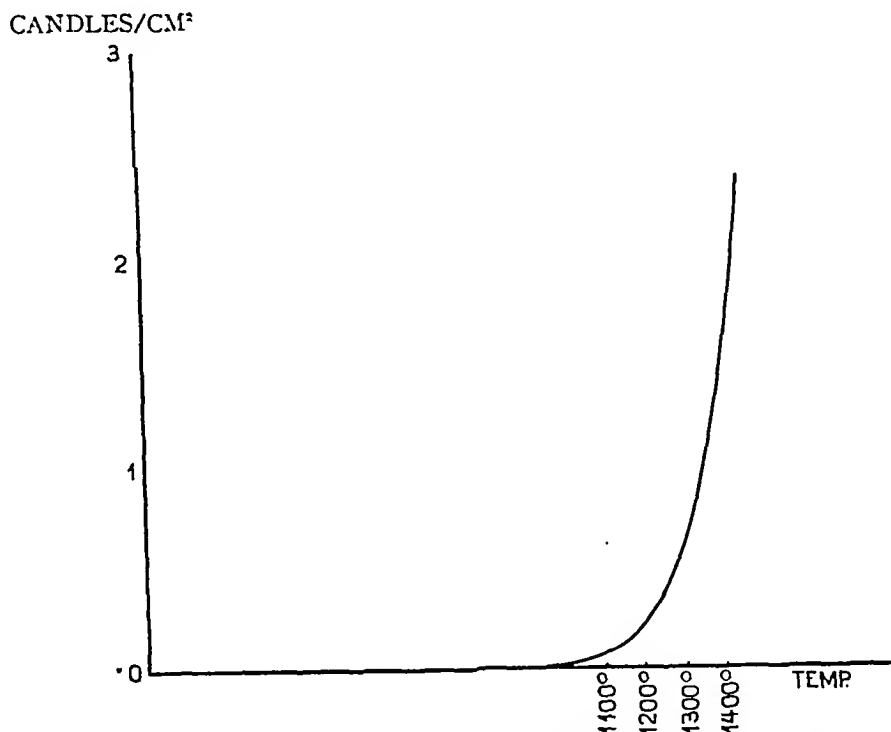


Fig. 1. Shows how a rough estimation of the light emission is sufficient for a fairly accurate measurement of the temperature.

certain that the voltage is really 50,000, for very often practical switch tables appear to be unreliable as soon as currents exceed 50 milliamperes.

It is really astonishing to find how simple the method appears to be after one has tried it. Even if two investigators work under quite different conditions (difference of anode surface, of lighting of the anode by the filament, darkness of the room), my experience has been that the difference in their results as a rule does not exceed 10

The determination of the size of the focal spot in the central direction, as has already been said, is made by the simple pin-hole camera. It is unnecessary to describe the instrument, the only possible mistake here being the effect of exposure time and the size of the pin-hole. The size of the picture is not quite independent of the exposure time and increases with the same, as shown in a recent paper in *Röntgenpraxis*.<sup>4</sup> A simple geometrical equation proves that the size

<sup>4</sup>C. H. F. Müller A. G., Bedingungen für Lochkamera-Aufnahmen. *Röntgenpraxis*, 1930, II, 382.

of the picture should be somewhat broader than the actual focus:

$$F' = F + 2d,$$

if  $F'$  is the width of the picture,  $F$  the width of the focal spot, and  $d$  the diameter of the pin-hole. This relation holds good

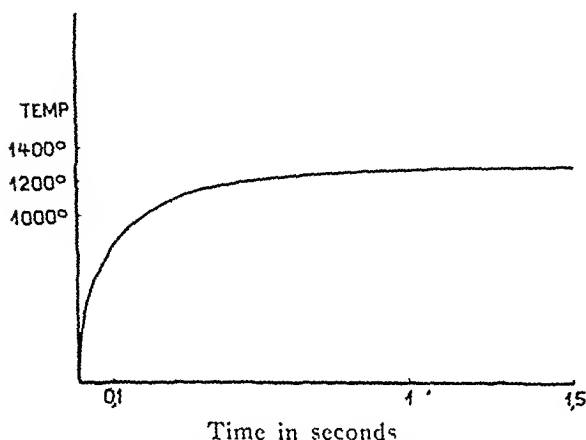


Fig. 2. Shows the slow rise of temperature of the anode after about half a second.

for equal distances between pin-hole and film, but only for a definite exposure time. With an exposure of 10 ma.-sec. at 50 K.V., the width  $F'$  of the picture, according to practical experience, will be very nearly  $F + d$ , if the pin-hole is 0.2 mm. wide and the distances between pin-hole and focus and pin-hole and film, respectively, 15 centimeters.

Now let us assume that for the current necessary to cause the "glow" as described above, we found again 60 ma., and for the surface of the "effective" focal spot  $3.2 \times 3.2 = 10.2$  square millimeters. Then the quality

$$Q = \frac{60}{10 \cdot 10.2} = 0.6 \text{ (very nearly).}$$

Testing a good line focus tube on "quality" one will always find about

$$Q = 0.6, \text{ sometimes } 0.7 \text{ or even } 0.75.^5$$

A tube with a "quality" of less than 0.5 should definitely be rejected unless, of course, one wishes to employ circular focus

tubes, in which case the "quality" never can be more than about 0.35.

The striking difference in "quality" between line focus and circular focus tubes is due only to the difference in projection angles, as explained above. The conclusion is correct that for the same definition a line focus tube can carry a load which is more than twice as large as the permissible load in the case of a circular focus, as long as the desired beam of radiation forms a small angle with the "central ray." That is to say, for all cases in which the length of the film, measured in the direction of the tube, is small in comparison to the distance from focus to film, as is very often the case in practice.

#### LARGE FILMS AND SHORT DISTANCES

We now come to the discussion of the case of a large film at a short distance, in which instance the part of the film nearest to the cathode will have the poorest definition, and we have to investigate whether or not the definition at this part of the film appears to be poorer in the case of a line focus than in the case of a circular focus, or otherwise.

Let us consider a  $14 \times 17$  inch or a  $35 \times 42$  cm. film at a distance of 25 inches or 64 centimeters.<sup>6</sup> We determine the most unfavorable direction of radiation, which proves to be at  $18^\circ$  with the "central ray" or at  $38^\circ$  with the anode surface in the case of a line focus, and at  $64^\circ$  in the case of a circular focus.

$$\frac{21}{64} = \tan 18^\circ.$$

In order to see whether a line focus tube gives a poorer definition in this direction than a circular focus of the same area, we have to determine the length of the "effective focus" in both cases.

Let the line focus have a width  $a$ ; its length will then be  $3a$  and its area

$$3a \times a = 3a^2.$$

<sup>5</sup>Which would mean 250 watts per square millimeter.

<sup>6</sup>Compare RADIOLOGY, October, 1929, XIII, 288.

The actual shape of a circular focus is an ellipse with an area

$$\frac{\pi l^2}{4 \sqrt{2}}$$

if its length is 1. If both areas are equal

$$\frac{\pi l^2}{4 \sqrt{2}} = 3 a^2$$

or

$$l = 2.32 a.$$

The length of the "effective" line focus will be

$$3a \sin. 38^\circ = 1.8 a$$

and the length of the "effective" circular focus

$$2.32 a \sin. 63^\circ = 2.1 a.$$

Even if one wishes to consider not the length of the focal spot but that of the diagonal of the rectangle, the latter will prove to be  $2a$ , and, therefore, also smaller than the length of the "effective" circular focus. But then, it is easy to show that the extreme corners of the rectangle contribute very little to the total energy, and, therefore, the length of the diagonal is really too pessimistic a measure for the sharpness. Only for the very corners of the  $14 \times 17$  film, it must be admitted that the longest diagonal of the "effective" line focus becomes exactly as long as the maximal diameter of the "effective" circular focus, *viz.*,  $2.3 a$ .

It follows that the sharpness of definition in the most unfavorable direction is better with a line focus than with a circular focus, even if films of  $14 \times 17$  inches are used at a distance of 64 cm., which is, I believe, hardly necessary in practice. The calculated data do not express the difference in average definition at the most unfavorable part of the film, but only the difference in definition in one direction.

The difference in favor of the line focus is much greater for all other parts of the film and even much greater for all parts if we use the film at right-angles to the tube, in which case the breadth of the focus will

be parallel to the long dimension of the film. It was, however, our intention to discuss the most unfavorable direction of all, and we have chosen the largest size of film and the smallest distance probably ever used in practice with large films.<sup>7</sup>

#### THEORY AND PRACTICE

Although apart from this reasoning many experimental tests and many years of practical experience in radiology have proved the advantage of the line focus principle,<sup>8</sup> some investigators have come to the conclusion that the above-mentioned advantage does not exist.<sup>9</sup> It is hard to say by what complications of circumstances such results are not in accordance with the facts. I wish to make, however, a few general remarks.

(1) It is not always kept well in mind that the sharpness of definition is of great importance only if considered in its relation to the load-carrying capacity. It is quite clear that a tube with circular focus can give a better definition, at the same distance, than another tube with a line focus. But what we have tried to prove in this article is that in such a case the line focus withstands a much heavier load. This is not a circumstance of secondary importance, but, on the contrary, the quintessence of the question. The advantage of the heavier load can be applied to obtain a better definition: first, by increasing the distance; second, by decreasing the exposure time and therefore the effect of the displacements of the object, and third, by partly combining both improvements.

(2) On some occasions we have proved

<sup>7</sup>See Footnote 6.

<sup>8</sup>Compare H. Franke, Ueber die grundsätzliche Bedeutung einer für jede Belastung scharf zeichnenden Röhre. *Fortschr. a. d. Geb. d. Röntgenstr.*, 1925, XXXIII, 111.

H. Franke, Comparaison pratique de la finesse des radiographies: Les Rayons X. *Revue Trimestr. de Clinique et de Thérapeutique*, 1926.

L. G. Heilbron, Ueber eine neue Röntgenröhre mit sehr grossem Scharfe Index. *Fortschr. a. d. Geb. d. Röntgenstr.*, 1922, XXIX, 299.

I. S. Hirsch, Discussion of Self-protecting Tubes and Their Influence on the Development of X-ray Technique, A. Bouwers. *RADIOLOGY*, September, 1929, XIII, 191.

<sup>9</sup>See M. Belot, *Jour. de Radiologie*, IX. Also W. C. Barker, *RADIOLOGY*, October, 1929, XIII, 283.

that the line focus tube had not been used in the right position. Care should be taken that the tube itself be almost parallel to the film and that the "central ray," perpendicular to tube and film, pass through the center of the latter.

(3) The comparison of two reproductions of radiograms is sometimes misleading. If details in one reproduction seem to be more pronounced than in another, there is, apart from the variations incident to the process of reproduction, the question of the distance of the details in question from the film. An object nearer to the film in one radiogram will certainly show sharper with the worst tube than a similar object taken with the best tube at a disadvantageous distance from the film.

(4) If two radiograms are compared,

one made with a fine focus tube and the other with a broad focus tube, one can always find parts so near the film that they show with almost equal clearness. This is, however, like comparing a high power racing-car and a moderately slow machine, running both at ten miles an hour, and stating that there is no difference in speed.

(5) The writer of the present paper has refrained from publishing some of the numerous experimental proofs that the line focus gives better definition in every possible case in practice, because he hopes that the reasoning in this paper is a better proof than any reproductions can be.

To the writer it seems that these remarks may contain the key to the explanation of most of the discrepancy between theory and some practical results.

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# COMPARISON OF X-RAY DIFFRACTION INTENSITIES WITH STRUCTURE FACTOR COMPUTATIONS IN LIQUID LONG CHAIN COMPOUNDS

By ROSS D. SPANGLER, University of Iowa, IOWA CITY, IOWA

*Abstract.*—The concept of effective molecular grouping in liquids is used as a foundation on which to base computations of relative intensities at certain angles of diffraction of X-rays from eleven n-alcohols and twenty-two octyl alcohols. The intensities are obtained

by calculations of structure factor based upon an assumed but reasonable molecular structure. The satisfactory nature of the comparison adds evidence distinctly in favor of the molecular group conception of the cause of the diffraction haloes in liquids.

**K**NOWLEDGE of the nature of the liquid state is of fundamental importance. One of the methods of approach is a study of the arrangement of molecules in liquids. This aspect has been emphasized at this laboratory, the name cybotaxis being given to the molecular groupings found in liquids.<sup>1</sup> But, as usually is the case in fundamental problems, the evidence involves interpretations and can wisely become convincing only by an accumulation of data from every possible angle of approach. The cybotactic view is one of importance, for, if correct, it should supply the conception necessary for more complete theories of numerous phenomena in liquids, such as viscosity, solubility, and osmosis. The purpose of the present paper is to add pertinent evidence through quantitative comparisons of the relative intensities in X-ray diffraction haloes in liquids with similar values computed from structure factors.

The dotted line curves in Figure 1 show the relative ionization intensities<sup>2</sup> in the X-ray diffraction in the n-alcohols from methyl to lauryl, inclusive. The zero points of the ordinates have been shifted to make possible the presentation in one figure. Two peaks in each curve are noticed. The larger one is interpreted as corresponding to the lateral separation of these chain molecules and the smaller one to the longitudinal separation, the word "separation" referring to the dif-

fraction centers of the molecules.<sup>3</sup> It ought to be possible to make a comparison of the relative intensities of any one substance by computing the structure factor and adopting the space arrangement of the molecules just mentioned. Such has been the method.

Since we are not dealing with crystalline structure, but with groupings that are unstable and crude approximations thereto, several assumptions are necessary in order to make the comparisons. They are as follows:

(1) The electrons in an atom scatter X-rays classically and may be regarded as concentrated at the center of the atom. In justification for both assumptions the small angle of scattering should be noted. (2) The structure of the molecule may be obtained from the general conception in chemistry of such long chain molecules combined with certain measurements in X-ray diffraction in n-paraffins and n-alcohols, and from the crystal structure of diamond. (3) The group arrangement is regarded as that already suggested by the workers in this laboratory. (4) The classical theory of structure factor as developed for crystals may be applied to the liquid groups as a first approximation in the computation of relative intensities at different angles.

In accord with Assumption (2) the arrangement of the atoms in the molecules is found by a succession of steps. The lengths of a homologous series of molecules of n-

<sup>1</sup>See Stewart: Phys. Rev., 1930, XXXV, 726, for the evidence for this view.

<sup>2</sup>Obtained by Stewart and Morrow, *loc. cit.*

<sup>3</sup>For the details of the arrangement suggested the article by Stewart and Morrow, *loc. cit.*, should be consulted.

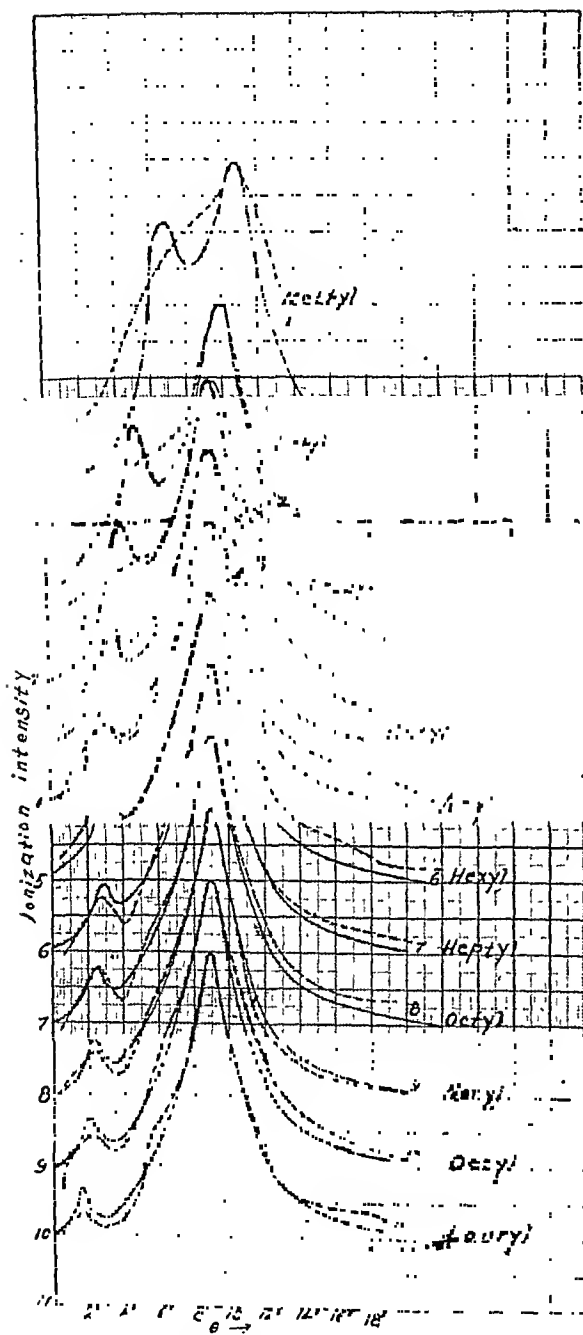


Fig. 1. Comparison of experimental and structure factor diffraction curves for n-alcohols.

alcohols and n-paraffins are computed by a formula<sup>4</sup>

$$L = \frac{\text{Mol. Wt.} \times M_H}{\text{Density} \times d^2}, \text{ wherein } d \text{ is the}$$

separation normal to the direction of the chains found by X-ray diffraction. The chains are in a square array.  $M_H$  is the

mass of an H atom. Knowing  $L$ , the increase in length of a molecule per C-atom is found. The increase found for alcohols is 1.25 Å.u., and for the paraffins, 1.25 Ångström unit. With this accepted, the amount contributed by the end groups of the molecules, OH + H for the n-alcohols and H + H for the n-paraffins, are readily computed. These lengths were found to be, respectively, 2.08 Å.u. for the alcohol molecules and 2.62 Å.u. for the paraffins. In the paraffins, then, each H-atom contributes 1.31 Å.u. to the length of a molecule. Assuming that a similar geometrical arrangement occurs at the H end of the n-alcohol molecule, we have  $2.08 - 1.31 = 0.77$  Å.u. as the amount contributed to the length of an alcohol molecule by the OH-group. This space allowed to the OH-group is somewhat small, but if we think of the C-atoms being crowded about the OH-group, which does not seem improbable, the result is not unreasonable. This crowding has been pointed out by Müller when dealing with solid crystals of long chain compounds.<sup>5</sup> Of course it is to be understood that the foregoing estimations of the space occupied by OH and H are not considered accurate except as they are sufficiently so for the purpose of this paper. If the diameter of the C-atom may be taken from the diamond as 1.54 Å.u.,<sup>6</sup> the C-atoms in the molecules concerned cannot, according to the foregoing measurements of 1.24 and 1.25 Å.u., lie on a straight line. If the C-atoms are connected to one another in a zig-zag manner at the tetrahedral angle found in the diamond, the distance between successive centers of C-atoms along the chain will be 1.255 Å.u., or very nearly the value computed above. This arrangement of the C-atoms in a zigzag manner has already been pointed out in the case of solid crystals of long chain compounds.<sup>7, 8</sup> Since the C-

<sup>5</sup>A. Müller: Proc. Roy. Soc., 1927, 114 A, p. 542.

<sup>6</sup>W. H. Bragg: Introduction to Crystal Analysis, 1929 Ed.

<sup>7</sup>Müller and Shearer: Chem. Soc. Jour., 1923, CXXIII, 3156.

<sup>8</sup>A. Müller: Proc. Roy. Soc., 1928, 120 A, p. 437.

<sup>4</sup>G. W. Stewart: Phys. Rev., 1928, XXXII, 153.

atoms are connected to one another at tetrahedral angles, the H-atoms which belong to the long chain molecule may be assumed to be connected to the C-atoms at the same angle. This gives us a fairly definite model of a n-alcohol molecule on which to base our calculations. Having selected a structure of the n-alcohol molecule, the computation of the structure factor for any set of planes in the molecular group is obtained by the formula,<sup>9</sup>

$$F = \sum n_l \cos \left( 2\pi \frac{2z_l \sin \theta}{\lambda} \right),$$

where  $n_1$  is the number of electrons in an atom at a distance  $z_1$  from a diffracting plane containing the diffraction centers.  $n_1$  and  $z_1$  are summed up over the molecule. The arrangement of the molecules is assumed, as stated by Stewart and Morrow (*loc. cit.*), and is briefly described as consisting of an end-to-end longitudinal arrangement with polar groups adjacent and with these long chains, thus formed, parallel and in a square array.

In addition to the n-alcohols, twenty-two octyl alcohols are similarly treated. The details of the structures assumed will not be described, but they are in accord with the arrangement of molecules suggested by their diffraction curves.<sup>10</sup>

In terms of  $F$ , the energy in a scattered beam is assumed to be proportional to  $F^2 / \sin 2\theta$ .<sup>11</sup>

If  $F_1$  and  $\theta_1$  refer to sets of planes which are parallel to the lengths of the molecules and if  $F_2$  and  $\theta_2$  refer to sets of planes through the ends of the molecules,  $\frac{F_2^2 / \sin 2\theta_2}{F_1^2 / \sin 2\theta_1} = W_2 / W_1$  is the ratio of the energies of the diffracted beams from the two sets of planes. The values  $F_1$ ,  $F_2$ , and  $W_2 / W_1$  for the normal and octyl alcohols are given in Table I.

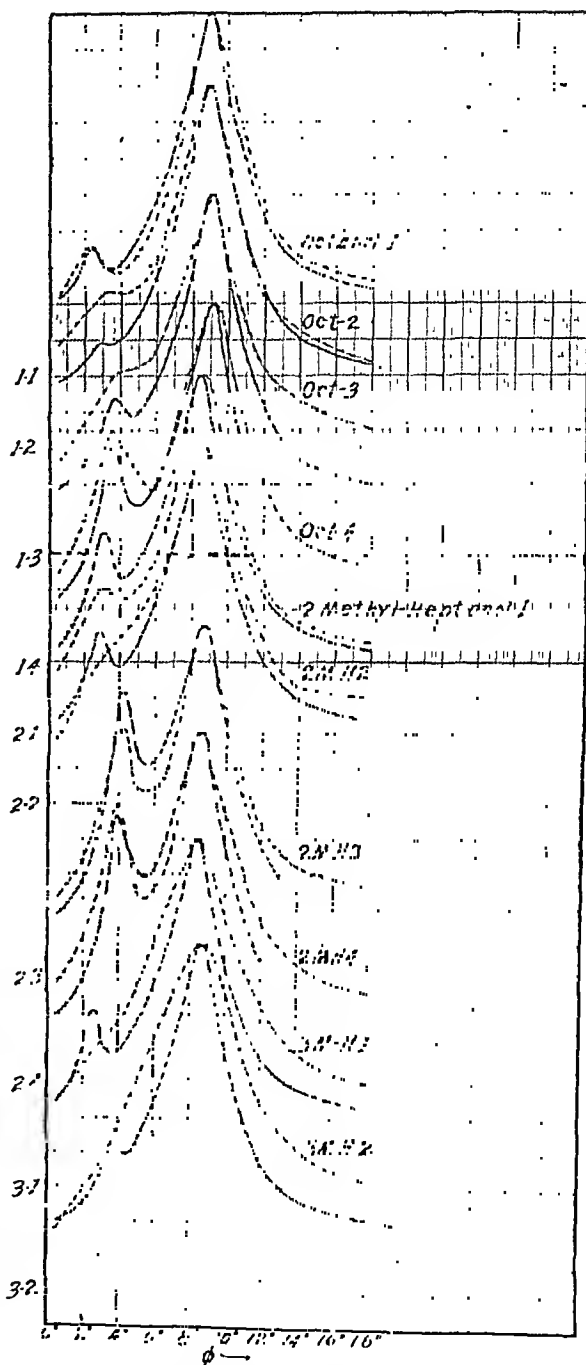


Fig. 2. Comparison of diffraction intensity-angle curves of octyl alcohol isomers and the curves constructed from structure factor computations.

It would now be possible to proceed with the comparison of  $W_2/W_1$  as computed, with the ratio of the heights of the corresponding peaks in the experimental dotted curves of Figures 1 to 4. But for the sake

<sup>9</sup>A. H. Compton: X-rays and Electrons, 1926, p. 121.

<sup>10</sup>G. W. Stewart: Phys. Rev., 1930, XXXV, 726.

<sup>11</sup>A. H. Compton: X-rays and Electrons, Chap. V, p. 125. The polarization factor is omitted because of its small variation at the angles herein used.



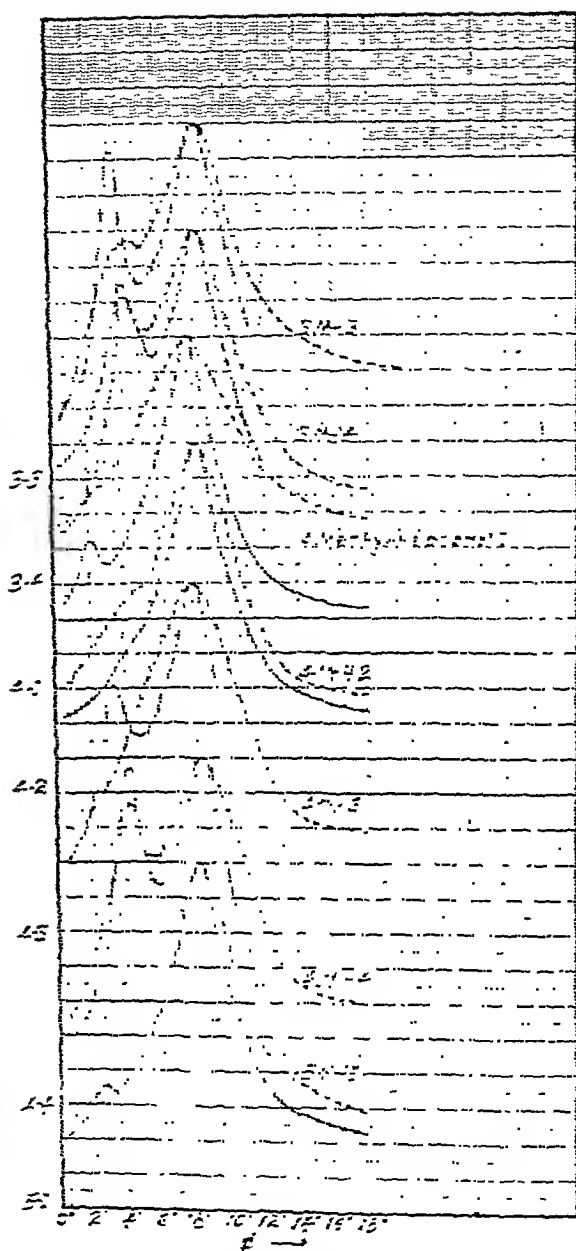


Fig. 3. Comparison of diffraction intensity-angle curves of octyl alcohol isomers and the curves constructed from structure factor computations.

of making the comparison more visual as shown by the full line curves in the above figures, it is necessary to assume the shape of the peak. This is taken to be that occurring in the *n*-paraffins. The width of this standard peak is assumed proportional to the angle of diffraction. The height of the peaks on the full line curves are now made to have the same ratio as the computed

TABLE I

|                     | $F_1$ | $F_2$  | $W_2/W_1$ |
|---------------------|-------|--------|-----------|
| Methyl              | 20.4  | 30.1   | .65       |
| Ethyl               | 21.8  | 41.7   | .492      |
| Propyl              | 22.3  | 53.4   | .424      |
| Butyl               | 22.6  | 65.0   | .315      |
| Amyl                | 22.68 | 76.6   | .246      |
| Hexyl               | 22.73 | 88.3   | .201      |
| Heptyl              | 22.8  | 99.9   | .175      |
| Octyl               | 22.61 | 111.7  | .155      |
| Nonyl               | 22.66 | 123.4  | .134      |
| Decyl               | 22.49 | 135.0  | .136      |
| Lauryl              | 22.37 | 146.6  | .139      |
| Octanol 1           | 22.61 | 111.74 | .155      |
| Octanol 2           | 15.51 | 99.5   | .076      |
| Octanol 3           | 39.7  | 99.5   | .222      |
| Octanol 4           | 43.28 | 99.5   | .446      |
| 2 methyl-heptanol 1 | 34.08 | 103.27 | .325      |
| 2 methyl-heptanol 2 | 25.34 | 91.84  | .245      |
| 2 methyl-heptanol 3 | 51.4  | 91.84  | .645      |
| 2 methyl-heptanol 4 | 47.8  | 91.84  | .584      |
| 3 methyl-heptanol 1 | 29.5  | 103.27 | .282      |
| 3 methyl-heptanol 2 | 20.7  | 91.84  | .169      |
| 3 methyl-heptanol 3 | 57.2  | 91.84  | .835      |
| 3 methyl-heptanol 4 | 56.39 | 91.84  | .745      |
| 4 methyl-heptanol 1 | 24.46 | 104.85 | .208      |
| 4 methyl-heptanol 2 | 15.0  | 95.54  | .073      |
| 4 methyl-heptanol 3 | 58.0  | 95.54  | .53       |
| 4 methyl-heptanol 4 | 60.6  | 95.54  | .8        |
| 5 methyl-heptanol 1 | 18.18 | 97.17  | .113      |
| 5 methyl-heptanol 2 | 9.56  | 95.54  | .029      |
| 5 methyl-heptanol 3 | 53.38 | 95.54  | .381      |
| 6 methyl-heptanol 1 | 12.81 | 103.27 | .05       |
| 6 methyl-heptanol 2 | 7.26  | 91.84  | .017      |
| 6 methyl-heptanol 3 | 44.7  | 91.84  | .29       |

$W_2/W_1$ , and the height of the chief peak is adjusted to correspond to the experimental. Also the angular positions are assumed to be that shown experimentally.

In making the above reduction of peak width when plotting for a smaller angle, the spread of  $24'$  caused by the apparatus is incorrectly altered also, but the error is too slight to warrant the more accurate procedure, since the visual effect would be scarcely changed thereby.

The curves for the normal and octyl alcohols, built up as described above, are shown in Figures 1, 2, 3, and 4, by the full lines. Superimposed upon each of the computed curves is the experimental one for the same sample, shown by the broken line. The

substances represented by the curves are indicated in each case.

#### RESULTS OF COMPARISON

Consider Figure 1, for the *n*-alcohols. There are ten of them. In all, except methyl, the comparison of widths of peaks shows good agreement. As regards intensities, in six of the ten there is good correspondence, that is, the two intensities at the smaller peak agree within about 30 per cent. Two others are within 70 per cent and with ethyl and methyl the agreement is poor. This poor agreement for the shortest molecules is to be expected, for the groups would be less well defined and hence our structure factor values would be less applicable. Also there is a known greater error introduced by the general radiation as the inner peak moves toward larger angles. The maximum of this general radiation is about  $6^\circ$ . One might, therefore, say that agreement in six of approximately eight fairly dependable curves is satisfactory.

In Figure 2, there is similar good agreement for six and perhaps seven of the ten. Perhaps a more detailed consideration of all the curves may be subsequently of value, but for the purpose of this article, the discussion will be limited. In Figure 3, four of the seven pair have good correspondence. In Figure 4, the correspondence is poor, except in one case of the five, but the inner peak is small. In this fact the agreement is satisfactory. Another significant fact is that only in four cases out of thirty-three is the experimental secondary peak more prominent than the computed one, whereas one would anticipate that our method would indicate better groupings for the smaller peak than really exist. To make clear the significance of the agreement and lack of agreement in the foregoing comparisons, it is well to bear in mind just what has been assumed. The four assumptions stated at the outset include not only the same reasonable assumptions that would be made with a pow-

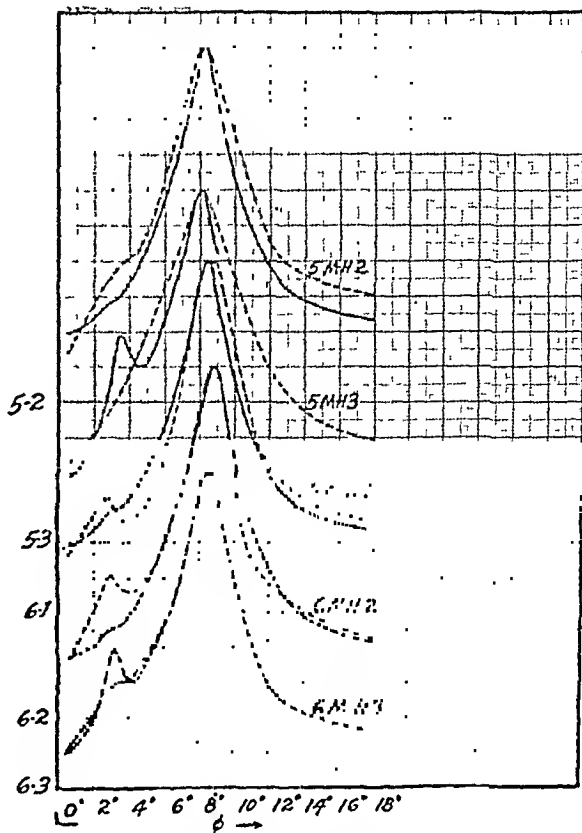


Fig. 4. Comparison of diffraction intensity-angle curves of octyl alcohol isomers and the curves constructed from structure factor computations.

dered crystal, but also the details of the structures of the molecules, those assumed to have a rigid shape. Errors must certainly exist in these details. Moreover, the rigidity of the molecule is very doubtful; indeed, there seems to be no experimental fact that demands it. The question arises, with such rough approximations to the truth, can any definite conclusions be reached? Clearly the agreement in Figure 1, as explained, is satisfactory and is excellent evidence for the correctness of the cybotactic or group view. In all the other compounds shown, with the exception of octanol-1, or *n*-octyl alcohol, the molecules are not straight chains but have one or more branches. But our assumed structure states that these molecules are not warped by their branches in any way. In spite of the possible large error entailed by this assumption, there remains for the most

part a striking resemblance of the actual and the constructed diffraction curves.

When one considers the limitations of the method of comparison here proposed, he must conclude that the evidence adduced by

the comparison favors strongly the correctness of the view that molecular unstable groups of molecules, simulating crystal powder, are to be found at any instant throughout the liquid.



**Anomalous Enlargement of the Liver and a Dissecting Hematoma of the Phrenic Nerve: Case Report.** Karl Kornblum and George W. Stephenson. *Am. Jour. Roentgenol. and Rad. Ther.*, July, 1930, XXIV, 38.

The authors report an interesting and unusual case of anomalous enlargement of the liver occurring in a patient 16 months of age, who had been examined clinically and roentgenologically on several occasions just prior to death, and postmortem examination. By roentgen study, a dense shadow was observed at the right base which, on the lateral film, gave the impression of being produced

by an accumulation of fluid encapsulated between the middle and lower lobes. Upon postmortem examination, however, this was proven due to an anomalous enlargement of the right lobe of the liver, the thickness of this lobe being 15 centimeters. There was no evidence, either gross or microscopic, of any liver pathology. The writers were unable to find in the literature any reference to the frequency of occurrence of anomalous lobulation, except the statement by one authority that the condition is not rare.

J. E. HABBE, M.D.



## WHAT SHOULD BE DONE ABOUT CANCER?<sup>1</sup>

By H. J. ULLMANN, M.D., Director, Department of Radiology and Cancer Research,  
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THOSE who desire to accomplish most for humanity in the field of cancer must survey several lines of effort for the possibilities of producing results.

1. Laboratory research to determine the cause of cancer.

2. Search for a specific cure.

3. Improvement and standardization of known methods of treatment.

4. Making such methods available to cancer sufferers.

5. Education of physicians and public.

1. *Search for cause.*—This has been going on for two generations, with the expenditure of millions of dollars, and, so far, we are but little nearer the answer. It can well be left to the few centers already engaged and experienced in the work.

2. *Search for cure.*—Man has looked for panaceas from the beginning of time; in the Middle Ages, for the fabulous philosopher's stone that would cure every ill—in more recent times for a specific remedy for a specific disease. Some success has rewarded such search, for example, quinine in malaria, antitoxin for diphtheria, serum for epidemic meningitis.

Man is still seeking such a specific for cancer, the scourge that cuts him off in the most productive period of life. Whether such a cure shall consist of an amulet hung around the neck, a "radio-active" drinking water, or a marvelous substance to be injected into the body, depends on the relative ignorance of the searchers.

For reasons that are only too painfully obvious to the intelligent student of cancer, it

is extremely unlikely that any specific cure for cancer will ever be found, as cancer is not a single disease but the name of a whole group of diseases with certain common characteristics. Research which holds so little hope of success seems questionable judgment. But this does not apply to the development by clinical and laboratory research of successful methods of treatment when intelligently and skillfully applied, alone or in combination with other methods, even in the absence of a specific cure. The best example of the result of such research is insulin, a successful treatment but not a cure for diabetes.

It is believed that any effort toward relieving or attacking the cancer situation as a whole will go much farther in saving life and relieving suffering than if devoted to clinical or laboratory research alone. Clinical and laboratory research can not accomplish much without adequate facilities for caring for and treating cancer patients. If only a certain sum of money is available, it must be divided between furnishing these facilities and the laboratories. If it is spent entirely on what one might call "pure research" in the laboratory, much of the work will necessarily be abortive.

To be told that one has cancer does not necessarily mean a death sentence. The percentage of actual cures among the commoner forms of cancer is being increased every year as physicians become more and more skilled in the use of established and proven methods, and improvements in these methods are developed or discovered. Each year shows a steady and, in some instances, rapid increase in the percentage of cures within definite groups of cancers, and such orderly development in the treatment and

<sup>1</sup>Read before the Radiological Society of North America, at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1-5, 1930.

cure of this dread disease should proceed faster and faster as our knowledge increases.

At the present time many people are dying unnecessarily from cancer. There are several reasons for this situation. A slowness on the part of the patient to seek advice or submit to treatment after he knows that he has cancer is one. This may be classified as the ignorance of the public. Another is the lack of familiarity with the early signs and symptoms of cancer by a large proportion, probably a majority, of the medical profession. The lack of knowledge among physicians regarding advances in methods of treatment and possibility of cure leads them to pronounce cases hopeless, or to use only palliative treatment, when the percentage of cures from the best cancer clinics may be 30 per cent in that particular type of cancer. This may be classified as ignorance within the medical profession.

Few centers are equipped with adequate facilities for treating all types of cancer. These facilities consist of sufficient radium, roentgen-ray equipment, and a trained personnel—surgeons, radiologists, pathologists, and laboratory services—for both clinical and laboratory research. As it is possible for only a few patients to reach one of these centers, many deaths may be classified as due to lack of proper facilities.

There are three time-tried, accepted methods of treating cancer with a definite prospect of cure, and the percentage of cures, as has been stated, is increasing year by year. The exception is a small group of exceedingly malignant growths within which no cures have ever been reported.

The oldest of these methods is surgery. Surgery, however, has reached its limit, for, although the surgeon of to-day can remove practically any portion of the body that is not needed to support life, cancer may attack such regions or organs as are beyond his reach.

The second is the use of radium, the

roentgen ray, or both in combination. Although their employment is recent, compared to surgery, they have become, when properly used, nearly as important, especially radium. Their importance has been well brought out in a recent report from the Cancer Commission of the League of Nations (1), and the last Annual Report of the British Empire Cancer Campaign to the House of Lords. The development of new methods of using radium, with accompanying improvements in results, is occurring so rapidly that it is difficult for any one not devoting a large part of his time and interest to the work to keep up with the rapid changes.

The third is a combination of surgery with radium and roentgen rays. This last furnishes the highest percentage of results in many of the more serious groups of cancer, but necessarily, to obtain these results, requires the closest co-operation between the surgeon, the radiologist, the pathologist, and the research laboratory.

There are other methods being continually tested, some of which show promise, but they are all so new that, although much work is being done both in developing and testing new methods, they will not be discussed.

This is the situation as it exists to-day, and the method of meeting it might be summarized under three heads: (1) Education of the public and the profession; (2) establishment of institutes with facilities for the care and treatment of cancer patients; (3) research. These can and should be combined in the larger centers and in many of the smaller.

Physicians are often responsible for donations for medical purposes, and where not directly responsible are usually called upon for advice. This paper is a plea that, so far as possible, those making donations to combat cancer be not only advised but urged to give their funds to meet the cancer problem

as a whole, not for any particular phase. The present tendency is, as soon as funds are provided, to erect and equip elaborate laboratory buildings, and the director of research is instructed to search for the cause of or a cure for cancer. No consideration is given those sufferers who might be relieved or cured if proper facilities for their care and treatment were provided. Each fund should be divided into three parts by the medical advisory board, and the relative size of these parts varied from time to time as the local situation demands. In this way the work will be balanced and the greatest benefit be obtained from any given amount of money available. For example, the laboratory research in an institution may reach an *impasse* or become abortive for lack of clinical material. The medical board may then divert sufficient funds to supply hospital accommodations until such time as the clinical research has caught up with the laboratory. Or again, the local situation may require a major portion of the budget to furnish facilities, such as radium, or to equip a clinic in order to obtain the greatest benefit for the cancer sufferers in that locality.

The physicians in the surrounding territory must be taught to recognize cancer and what to do when it is found. They must be taught that the treatment and diagnosis of cancer is a group problem and that team work with their colleagues is essential. They must be taught that the hopeless cancer sufferer must not be left to die with morphine as his only aid, but that the duty of a physician is to relieve suffering as well as to cure disease. The cancer sufferer is entitled to as much care and thought as the incurable cardiac patient. It is unfortunate that he rarely gets it, and I have discussed this phase in a previous paper (2).

With institutions in the larger centers completely equipped and adequately staffed,

each with laboratory facilities for research, diagnostic centers should be established in the smaller cities. Such a smaller center must be complete for its purpose and the staff must include a trained pathologist. Here patients may be referred for diagnosis and advice, for the staff must be in constant touch with the parent institution. Patients who can not be properly treated locally are referred to the large treatment center, where all facilities, including free care for indigents, are available. It is economically unsound to install expensive roentgen outfits and large supplies of radium in every city. These should be concentrated in the special centers and these centers distributed so far as possible that they may serve the surrounding population with the minimum of transportation problems. Close co-operation with the public health services should be maintained. These are particularly valuable in keeping check on patients after treatment.

There is much money and effort being wasted from lack of organization and ignorance of the problems involved. It has been said that a problem formulated is half solved. I hope that what has been said will aid in that formulation.

#### SUMMARY

Many persons are dying unnecessarily from cancer because of the ignorance of the public and within the medical profession.

Many of these could be saved or relieved of much of their suffering if funds now supplied for special phases of the problem could be devoted to the problem as a whole.

Funds and effort should be divided between education of the public and profession, supplying facilities for care and treatment, and research, both clinical and laboratory. The size of each fraction must necessarily vary with both place and time.

Team work in the diagnosis and treatment of cancer is an absolute essential.

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The X-ray Examination of Called-up Men and Recruits in the Swiss Army. H. E. Walther. *Acta Radiol.*, 1930, XI, Fasc. 4, No. 62, p. 411.

Since 1923, X-ray examination of the called-up men and recruits has been routine in this division. Fluoroscopy is done by an experienced physician, and films are made of the chests of all those with suspicious screen findings. The roentgenograms serve as objective records of the men's conditions. In the period from 1927 to 1929, 20,000 men were examined in this manner, 1 per cent being found to have chronic pulmonary tuberculosis of which they had no symptoms. In recruits who had previously passed several medical examinations, from four to five per thousand were also found to have tuberculosis. Infil-

trative lesions in the upper lobes were the commonest, and in half the cases the disease was bilateral.

The author emphasizes the economic advantage in discovering these cases before they enter military service, also the saving of time in the roentgen examination, as compared with the complete physical examination of the chest. He reiterates the general experience that X-ray investigation will disclose many lesions undiscovered on physical examination. Figures show that practically all the cases of open pulmonary tuberculosis in the Swiss Army occur among recruits from the posts where X-ray examination of the men is not done on entrance into the service.

A. L. HART, M.D.

## WHAT SHALL WE TEACH THE PUBLIC IN REGARD TO CANCER AND HOW SHALL WE PRESENT IT?

By D. T. QUIGLEY, M.D., F.A.C.S., OMAHA, NEBRASKA

THE prevention of any disease depends on an understanding of the factors which have produced it. These factors may be single or multiple, specific or non-specific. They may lead to one individual specific factor, as in tetanus, diphtheria, or syphilis, or they may involve several etiological factors, as in cystitis, tonsillitis, or pneumonia.

One of the outstanding points in most of the studies which have been made on cancer is that most of the men engaged in this research seem to base their work on a preconceived idea, and to assume that there is one specific etiological factor for this disease, and that eventually this one specific etiological factor will be discovered. Some of the workers in this field have gone a step farther and have assumed that the etiological factor, when found, must of necessity be a living organism. Others have gone farther yet and assumed that, once the organism is found, an antitoxin will be elaborated which will cure all—even advanced—cases by the simple method of injecting it into the afflicted body.

For none of these assumptions is there any foundation in fact. No one has any right to assume that the great group of diseases called "cancer" has one specific cause, that the cause is a specific organism, or that any antitoxin is possible. On the contrary, all known facts seem to point in the opposite direction.

During the last twenty years it has been proven that cancer is increasing. With the knowledge of the increase in the incidence of the disease has come a very great interest in the whole question, from the standpoints of prevention and cure. Especially during

the last ten years much has been said about prevention, and an active campaign directed to this end has been carried on by the American Society for the Control of Cancer. However, the usual attitude assumed at present is that, since we know no single specific etiological factor, we know nothing about cancer—that there is no prevention and no cure. Many of the men presuming to educate the public in regard to cancer and its prevention preface their remarks by saying, "We know nothing about the cause of the disease, and, as far as scientific knowledge at the present time goes, there is no cure." Such an introduction serves to discredit everything the speaker may later say, causing the listener to lose confidence in the efforts made by so-called scientific medical men along this line, and leaving the door open for him to place his confidence in those who least deserve it. If nothing is known about the causation of the disease, then it would seem that efforts directed toward prevention must be illogical and unproductive of good results. If certain etiological factors are known, then preventive methods may be recommended to the public to the extent of such knowledge.

Etiology in cancer should be expressed in the plural instead of in the singular. There are undoubtedly multiple etiological factors in different anatomical locations, and in various ages, and in both sexes.

Cancer itself is simply an exaggerated defense-reaction on the part of the body in which many new cells are produced. These new cells are apparently the last line of defense thrown out in a losing battle with extrinsic agents. These extrinsic agents are of many kinds and of such a nature as to supply the irritation which, inflicting a certain cell injury, calls out the healing cell-

<sup>1</sup>Read before the Radiological Society of North America at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1-5, 1930.



building response. There is a considerable degree of similarity between ordinary healing and cancer growth: the only difference is that in ordinary healing the production of new cells is completely stopped when a sufficient amount of healing has taken place to compensate for the injury done. In cancer, a certain number of new cells are produced in response to a like stimulation, but in this case conditions are such that the stimulation is autonomous and continuous, and cell growth resulting therefrom also becomes autonomous and continuous.

The cell growth which we call cancer is not a well ordered, balanced, well fed, and well nourished group of cells like normal body cells, but a haphazard, badly nourished aggregation of cells, fed by chance and not supplied with nerves. This parasitic aggregation of cells is constantly growing and dying. It contains the very much alive, proliferating, penetrating group that is in the forefront of the neoplastic mass. This invading, proliferating group of cells is very much alive and takes nourishment direct from the tissues invaded. The group of cells that has aged somewhat and has been mechanically pushed a distance into the background by the newborn cells is not enjoying the full tide of life, but is somewhat reduced in vitality, or sickened. In the zone farthest removed from the advancing margin of the malignant growth there is complete necrosis, which harbors the saprophytic micro-organisms which exist in all dead and dying bodily tissues. The cancer, then, is a thing which is actively living and invading at one end and dying at the other end, with cells undergoing all the different degrees of sickness, starvation, and degeneration between these two zones. The advancing and invading end of the growth is accompanied by a round-cell infiltration which ordinarily is interpreted as indicating the presence of micro-organisms. The etiology of the disease seems in every case to be bound up with

the presence of some kind of low grade micro-organisms.

In external parts of the body where the disease may be studied, ulceration and local germ invasion may be demonstrated for a definite period of time before actual proliferation of epithelial cells takes place. Sections of glands in the neighborhood of cancerous areas show round-cell infiltration and swelling due to the presence of micro-organisms before any actual cancer transplants become grafted into the glands. It seems that there is sufficient evidence to convince anyone who has had a considerable laboratory and clinical experience that cancer is a thing growing on previously diseased tissue, and that the previously diseased tissue is tissue more or less shot through with irritating micro-organisms, these organisms and their poisonous products being the immediate cause of the cell proliferation.

As different parts of the body harbor different kinds of micro-organisms, we find many different germs acting in different etiologic ways to produce cancer. In the colon, we have the colon bacillus; in the throat, the streptococcus; in the skin, the staphylococcus; in the lung, the pneumococcus, etc. In these areas the wall of new cells probably serves to dam back the flood of invading micro-organisms, and it is probable that the life of the person is extended somewhat beyond what it would be did this exaggerated cell growth not serve to check the germ invasion. It must be remembered that whether the anatomical location be skin, mucous membrane, or gland, a thin layer of gland epithelium or squamous epithelium is all that lies between our internal parts and disaster. On one side of this epithelial layer lies an infected or potentially infected field and on the other side lies the sterile field which may not become infected without serious consequences. If a break occurs in the protective epithelium, micro-organisms immediately enter the deeper tissues, but if the break is immediately repaired by the growth

of new epithelium, no great harm is done. If, however, the epithelial wall is broken down repeatedly in the same place, then the group of cells whose function it is to furnish mechanical protection are stimulated to unlimited reproduction, with the result that we have the wild uninhibited growth of epithelium which we call cancer.

All the facts that we have available on the subject seem to substantiate this idea as to the beginnings of cancer. It is not supported by animal experimentation, but has the backing of a great mass of clinical and laboratory evidence. It is the best possible and most practical hypothesis we have available at the present time, and has potentialities for great good as it involves the eradication of all chronically infected disease foci which may become possible cancer-bearing areas. If every potentially malignant fibroid tumor, lacerated cervix, fistula, fissure, diseased gall bladder, papilloma, adenoma, pigmented mole, hemorrhoid, diseased kidney, appendix, diseased stomach and other chronically diseased organs and areas were properly treated, there would be no harm done and there would be enough work to keep the medical, surgical, and dental professions busy for many years, and cancer incidence and cancer mortality would undoubtedly be influenced for the better.

In all the discussions on prevention of cancer that have so far engaged workers in this field, nothing has been said save that which pertains to the local development of the disease. In no case has any real scientist alluded to any general constitutional condition that might predispose to cancer. However, it is possible that something of this kind must be taken into consideration before practical results are obtained. That some persons are more predisposed to the disease than others can not be denied. This same thing is true of every other disease. In the study of no disease have we been able to know just what this predisposition is, except in a general way in dealing with

infections of which we can say that resistance to infection is relatively high or relatively low. Along the line of high or low resistance to infections some actually proven animal work has been done. Infections of the eyes, tonsils, and sinuses are known to occur with mathematical certainty in animals that receive inadequate quantities of Vitamin A. Diseases of the nervous system and brain are known to afflict with very great certainty animals that do not receive enough Vitamin B. There is some well founded evidence to the effect that beri-beri and pellagra are infections on a deficiency basis. Infections of the teeth and mouth and other manifestations of scurvy are known to be associated with Vitamin C deficiency. Starvation for Vitamin D or lack of sunshine is definitely known to make the victim more susceptible to rickets and to infection with tuberculosis. A deficiency of Vitamin E is known to be associated with various forms of secondary anemia, and some at least of these, we may presume, are on an infective basis. Deficiency in iodine may bring about low grade metaplastic changes in the thyroid gland. Simple goiters carrying a small percentage of thyroid cancer may be produced in fish by keeping them in water which is deficient in iodine and which contains a relatively high percentage of the fishes' excretions. Deficiency in iron and copper may also produce a secondary anemia which reduces general resistance to infections. Deficiency of hydrochloric acid in the stomach may lead to the infection of the mucous membrane of the stomach and intestines with low grade micro-organisms.

It may be accepted as definitely proven that general or local resistance to infections may be reduced very much below normal by certain food and mineral deficiencies, or kept high by supplying the necessary food elements.

If cancer grows on old, chronic infections and if such infections are aided and assisted by certain food deficiencies, then these de-

ficiencies may indirectly act as predisposing causes of cancer, and it becomes evident that we must consider not only local but constitutional factors in the etiology of the disease.

Cancer may well be compared with other chronic diseases. In all of the well known ones it is universally acknowledged that nothing can be done for the patient in the way of cure if the disease is attacked in the advanced stage. In most of these diseases something of benefit to the patient may be done if the condition is discovered and treated sufficiently early. In our dealings with cancer we have thought only of some kind of treatment of the disease which would effect a cure of the advanced case. Nothing like this is expected in connection with any other chronic disease. The only reason why we have been expecting more in connection with cancer is because our lack of knowledge of this disease has been greater. Knowing little about it, we have expected the impossible. Much wealth and energy have been expended in the search for a magic cure for advanced cancer. We should now realize that the only way in which the situation can be handled successfully is through taking into account both local and constitutional factors and discovering and treating the disease in the stages before it has become advanced. In this connection we will be using the same line of reasoning that we use in handling the other chronic diseases. Cancer should be considered a chronic disease, and no more pessimistic outlook should be the rule in regard to cancer than with any other chronic disease.

In clearing the ground for progress the first thing that should be done is to disabuse the minds of medical men and the public in regard to magic "shot in the arm" cures. The things that have been expected of these cures in the field of cancer have never been accomplished in connection with any other disease; in other words, no disease is cured in its advanced stages. With what evidence

we have on the subject, the injection of metals, gland extracts, vaccines, antitoxins, or the "witches' broth" described in "Macbeth" are all equally childish and unscientific. The many claims which have stirred up considerable interest in recent years have all been shown to be without merit, although the promoters furnished what was apparently, at the time, some kind of scientific proof to sustain their theories.

As cancer cells are simply a multiplication of body cells, it is unreasonable to expect that any chemical substance will kill the one group of cells and spare the other. There is not only no hope for a solution of the problem along this line, but it is also evident that such a solution would not be to the best interests of the human race. Much more good is possible in prevention of the disease than in the cure of the advanced case.

Apparently the only bearing that heredity has on the situation is in the hereditary transmission of susceptibility to certain irritants. I believe it is fairly well established that a susceptibility to aniline dyes may result in cancer of the urinary bladder, and a susceptibility to certain other factors in the shape of chemical irritants or micro-organisms undoubtedly exists, in the same way showing a selective affinity for certain other parts of the body.

In addition to clearing the public mind of its misapprehensions in regard to a magic cure for cancer, we should do everything possible to change that point of view which assumes that we know nothing whatever about the disease or its causation. A greater confidence will be established if we assert that we do know something about the causation of the disease. The fact that we know no one specific cause should not obstruct the truth in this connection, and the error should be explained by the statement that we do know many causes of the disease. As fire may be produced in many different ways, and inflammation may be produced in

many different ways, so cancer may be produced in many different ways.

Cancer is known to grow commonly in scars, but practically never do we find cancer growing in a scar when the wound has healed by first intention. Cancer-producing scars are always those which have been infected, and in which incomplete healing has taken place by a slow process of granulation. There are many appendiceal scars, but cancer does not grow in such scars. Ulcers are known to be productive of cancer: yet in a normal, healthy individual ulcers have a tendency to heal, and in such ulcer scars there is no cancer growth. The ulcer which goes on to cancer-formation is an ulcer which has sustained repeated local insult, or exists in a person whose regenerative powers are so much below par that complete and satisfactory healing does not take place. Cancer is sometimes known to exist in persons apparently in a high state of physical good health. Here the local insult is present in such a marked degree that the disease develops in spite of good bodily health. Examples of this may be seen in some cases of cancer of the lip. On the other hand, the constitutional vitality of the individual may be low, inviting hematogenous dissemination of micro-organisms. Examples of this condition are the cancerous masses often seen in half-sick, anemic, semi-invalid, middle-aged persons, the disease attacking large complex glands like the breast in women and the prostate in men.

Jagged teeth cause cancer of the tongue, it is true, but they do so far more often in persons who are syphilitic. The irritation which causes cancer of the tongue in the syphilitic person is evidently seldom capable of producing the disease in one who is non-syphilitic. Local hygiene and constitutional hygiene both enter into the problem of prevention. The getting of this fact over to the rank and file of the medical profession and to the public is one of the most important things in the whole problem.

At this time the ideas held by the general practitioners in regard to cancer are very different from the ideas held by men who have had a chance to make a special study of the disease. Among the ranks of the surgeons there is, again, a very different aspect toward the disease. The surgeon is "sold on the idea" that there is nothing to be done for cancer except through surgery. The general practitioner has seen a sufficient number of surgical failures to convince him that surgery is not the answer to the question. Knowing no other means of combating the disease he becomes confused and pessimistic. The fault with the general practitioner is that he recognizes nothing as cancer until it has become advanced to that condition where it might be diagnosed by the average layman. Even then, to make matters worse, he insists on taking a piece out for microscopic examination. This clinches the diagnosis—and may spread the disease, as traumatism of any kind does—disseminate cancer.

In the United States about a hundred thousand persons die from cancer every year. In the same area there are about a hundred and fifty thousand doctors. If those persons who come to their death through cancer were evenly divided among the doctors of the country, there would be less than one case per doctor per year. This gives too small an actual contact with the disease for the average doctor ever to learn much from actual clinical experience.

In cancer clinics, such as the Memorial Hospital in New York and the State Hospital for Cancer in Buffalo, there are trained men who are capable of recognizing the disease in its earliest stages, because they have had abundant clinical and laboratory experience. These men have little opportunity to see the ordinary patient while the disease is early: the person who does have the opportunity is the general practitioner or family doctor. At present he is incompetent to give

the best service in this connection that modern science has to offer.

Within the last few years cancer cases have been appearing in increasing numbers in the practice of radiologists, cases which are usually treated and studied over a period of years. Many of them are advanced cases and have been subjected to other treatments, but some are early cases. This has given the radiologists an advantage not enjoyed by any other class of physicians. As all kinds of cases present themselves and the period of study is relatively long in the individual case, we may say to-day with assurance that the radiologists are in a better position to know what has already been discovered about cancer, and in a better position to impart this information to the other physician and to the public, than any other group. The experienced radiologist may speak quite definitely of cure in certain localized malignant conditions. We know, for instance, that localized lymphosarcoma and localized small round-cell sarcomas in children may be cured by proper X-ray treatment. We may just as definitely say that any localized accessible cancer may be cured by the application of a sufficient dose of radium radiation. In either case the cure is just as certain as the putting out of fire by the application of water. A little water will not put out a big fire, and a large amount of water on a small fire may make the water more destructive than the fire. Radium therapy and X-ray radiation in early localized cancer are entirely satisfactory in the hands of those who are experienced in their use and experienced in the diagnosis of the conditions which they presume to treat.

Those who have had a large clinical experience and sufficient laboratory knowledge may agree on certain known facts: first, that the formation of cancer depends on certain local irritations which may be mechanical, chemical, thermal, or infective. There is sufficient evidence to prove that cancer

always grows on previously diseased tissue, the words "previously diseased" in this connection meaning tissue which is harboring low grade micro-organisms. The constant association of cancer with low grade infections seems to justify the assumption that an etiologic relationship exists. Many infections exist in poorly nourished, overworked, badly housed individuals that could not exist in persons enjoying maximum good-health. Bad living conditions and deficient food predispose to the continuance of old chronic low grade infections. Infections of this kind predispose to cancer.

It is quite widely accepted that many benign tumors may take on malignant change. Benign tumors are known to harbor low grade micro-organisms, as old scars in wounds that have healed by slow granulation are known to harbor low grade micro-organisms. Out of many benign tumors, ulcers, and chronic infections, there may develop a few cancers. The removal of etiology in such cases, before the actual development of cancer, is sufficient to cure the patient. After the early local or superficial cancer has developed, the disease is usually curable, but is usually not cured, because of inadequate treatment. At a later stage we have the local cancer existing, with small cancer particles already present in the surrounding lymph vessels. The cancer is still curable. At a little later stage particles that have become separated from the main mass and have been carried into the neighboring glands have started secondary growths. The problem of curing the patient is now as hopeless as is the task of growing a new leg on a person who has had his leg amputated. The patient with metastatic cancer is and apparently always will be an incurable patient. The patient has arrived at this unhappy stage because of neglect or inadequate treatment in the earlier stages. Many danger signals have been passed unheeded, and to address ourselves to the problem of curing the patient in this unfortunate condi-

tion is as unreasonable as to attempt the rehabilitation of the engineer after he has passed red lights on the railroad. In the case of the engineer we would consider it more logical to insist on care in observing the danger signals. In the case of the cancer patient the problem must be handled the same way. Not the medieval idea of a magic cure after irreparable damage has been done, but the common-sense use of known facts in prevention and in the cure of the early case.

The local injuries which are commonly known to be pre-cancerous might well engage the attention of the medical profession. The ulcers, the leukoplakia, the jagged teeth in the mouth, the strictures in the esophagus, the ulcers in the stomach and duodenum, the old chronically infected stone-bearing gall bladders and kidneys, the localized and generalized colitis, the papillomatosis and diverticulitis of the colon, the rectal ulcers, hemorrhoids, fissures and fistulae, the old chronic infections in the prostate, the papillomas in the urinary bladder, the lacerations and ulcers of the uterine cervix, the malignant change in so-called fibroid tumors of the uterus, the malignant degeneration of previously benign ovarian cysts, the malignant degeneration occurring in previously benign adenomas and cysts of the mammary gland, these and many other well known pathological conditions may, if properly subjected to intelligent medical or surgical treatment, satisfactorily head off the development of malignant disease. A good many of these local conditions could not exist in a person or an animal with a high degree of resistance against infection. The laceration of the cervix which in the civilized woman leads eventually to death from uterine cancer probably occurs also in the Indian woman who does not have cancer. In the former, the healing is not complete and satisfactory, due to constitutional causes, and in the latter it is satisfactorily taken care of because healing power is high. The same

thing may be said in regard to the animals. The animals of the fields are practically free from cancer. The animals that live more nearly like humans have a higher incidence of cancer, the highest animal cancer incidence being in dogs, that live more nearly like humans than do any other animals, and that eat the deficient food which constitutes the leavings from the tables of human beings. Dogs that live more completely on the same foods as humans have a greater incidence also of colds, influenza, tooth decay, pyorrhea, paralysis and other nerve diseases. The more highly bred and carefully cared for are most subject to these diseases.

In conclusion, we may state that the etiologic factors in cancer are multiple, that the disease—like tuberculosis—is the result of localized injury and unhygienic living. It involves both local and constitutional factors. The almost constant association of chronic infections with cancer makes it evident that an etiologic relationship exists and that the invading micro-organisms and their toxins act as growth-promoting cell irritants. If this explanation be accepted, the etiologic factors in cancer become as plainly apparent as the etiologic factors in any other chronic disease.

The search for a cure for advanced cancer has led to misconceptions and aroused a false attitude toward the disease in the minds of both the public and physicians. To the person who has had a considerable clinical and laboratory experience in cancer, the magic cure idea for the advanced case seems futile and unreasonable. The successful solution of the problem can not be accomplished by this method of approach.

The group in the medical profession that is best fitted by experience and training to teach the public and the profession in this connection is that ordinarily designated as radiologists. The education and publicity committees of the Radiological Society of North America and the American Radium Society and other leading radiological

societies could well formulate a pronouncement on cancer to be given to the public through the usual channels which would do more toward the real understanding and solution of the problem than anything heretofore done along this line in the history of civilization. Such a beginning, properly directed, is capable of leading to a change in the understanding of the disease which might have much to do with the eventual control of cancer.

#### DISCUSSION

HENRY SCHMITZ, M.D. (Chicago): A knowledge of the direct or true cause of cancer is desirable but may not aid us in finding a specific cure. In illustration of this I may refer to tuberculosis; since we have known the specific cause of tuberculosis, we really have not advanced very much farther in its treatment. Whatever benefits have been derived have come solely through the clinical study of the disease and by early diagnosis and adequate care. At present, the cure of cancer consists in the application of surgery, irradiation, and electric coagulation—the latter, being purely surgical methods, should be included in the former.

Regarding the question of early diagnosis, I have always doubted whether or not the money spent on the education of the public in order to make it cancer conscious was well spent, or whether it would not be very much wiser to spend this money in the medical profession to educate it in the early recognition of cancer. As soon as we have organized all the facilities for the diagnosis and adequate treatment of these patients, let us invite the public to see what we can achieve. If we begin to recognize carcinoma in the beginning stage, from 80 to 90 per cent of all carcinoma sufferers may be cured. The reason so many die from cancer is that they are brought to us at a

time when they are purely and simply incurable and hopeless.

Cancer should be treated by a group of men who are specialists in the study of cancerous disease and who are especially trained in surgery and irradiation of carcinoma. There is a vast difference between a standard operation like appendectomy or mastectomy and a radical operation that must be performed in surgery of cancer in these particular regions. The condition in radiation therapy is similar. If we know the extent of a cancer in a given organ or region of the body, then irradiate the tumor-bearing area adequately, results should improve. A fixed cancer, a pelvic cancer extending beyond the limits of the true pelvic cavity, a breast cancer extending above the clavicle or into the mediastinum, are, as a rule, generalized cancers and cannot be arrested by any except the most radical method of treatment.

A group of men should be formed in each general hospital for the study, diagnosis, and treatment of malignant disease. The group should include an internist, a surgeon, an X-ray diagnostician, a radiologist trained especially in the radiation treatment of cancer, and a pathologist trained not only in general pathology but particularly in tumor pathology. If the cancer situation were handled as suggested by Dr. Quigley and Dr. Ullmann, and if the cancer specialists were to co-operate with the American Society for the Control of Cancer to induce them to assist in the organization of the medical profession in existing general hospitals, and to consult with the general practitioner and even the general surgeon in early recognition of carcinoma, and in adequate treatment, improvement in the control of cancer would be immediate.

ROLLIN H. STEVENS, M.D. (Detroit): As Dr. Schmitz has said so many things that I wanted to say, I am not going to try



to repeat any of them because he has said them so much better than I can. I want, however, to emphasize one point, and that is the great necessity of training men in the different specialties for the diagnosis and treatment of cancer—only such practitioners should be entrusted with the treatment of cancer. Such training of the specialist and education of the general practitioner are more important than the attempts to educate the public on subjects on which we have so little accurate information. False notions that I think are really harmful have been taught people in these cancer campaigns by physicians who have but little knowledge of the subject. We have had to take back many so-called "facts" that have been taught the public in these campaigns. If we, as radiologists, would keep in touch with the latest developments in cancer, develop and take part in clinics where patients would be examined and treated along the lines that are being gradually developed, and do what we can to educate other physicians, who, in turn, would look after their patients' interests, more would be accomplished than by spending so much time with the public, which hears so much it becomes cancer-phobic.

JAMES M. MARTIN, M.D. (Dallas, Texas): First, I want to indorse all that the Doctor has said and emphasize it, if possible. The lack of specific knowledge of cancer by the rank and file of the profession is pathetic. The specialists doing eye, ear, and nose work frequently treat cancer of the face, sinuses, etc., by temporizing methods, until the disease has passed beyond hope of a cure by any method. In our section of the country we seldom see cancer of the sinuses in the early stage. I would like to indorse the idea now being emphasized by the American Society for the Control of Cancer, namely, "educate the doctor first and, through him, the public."

DR. R. N. DELITCH (Pasadena, California): In Paris, in five years, the progress in the treatment of cancer by radium has shown from 34 per cent to 72 per cent gain—nearly double, or, more exactly—

(1) In 1919, of the total number of cancer cases treated by radium, only 34 per cent were found alive one year after the treatment.

(2) In 1925, of the total number of cancer cases treated by radium, 72 per cent were found alive one year after the treatment—nearly double.

Some specialists think that this progress is due to the better technic and better professional education. I really think that it is due, as well, to the education of the public and the better organization of the cancer propaganda.

I started to learn something about cancer with Professor Cerny, in Heidelberg, in 1911, and later, for about six years, in Paris with Professor H. Hartmann, who put me in charge of a cancer dispensary at a Montmartre institution which was not for the people going to Montmartre for a good time but for the poor people suffering and having hard times in that famous Paris district.

In my Montmartre dispensary or in a larger cancer hospital center, I had occasion to see some hopeless, incurable cancer cases coming late to the right cancer institution—coming late because they had been treated in some private office. For example, some cancers of the uterus had been treated as metritis, or some cancers of the rectum as hemorrhoids, and this not due to professional ignorance but for personal profits, sending those poor patients late to the cancer centers when there was no more hope for cure. In so doing, certain physicians were treating those cancer cases as if they were silver or gold mines, for the longer the time and the more often that those patients came to the physician's office and paid for the visits, the better it was for his



income. This is absolutely wrong: it is criminal to treat these patients so.

For this reason public education is as important as professional education. If, in Paris, we now have 72 per cent of patients alive one year after treatment, instead of the former 34 per cent (in 1919), it is due to public as well as to professional education. Thanks to cancer propaganda, persons come sooner for treatment and know the right place to come. We have in Paris, as you have certainly here, some wonderful nurses and volunteer workers. They used to go to the public markets, schools, and poor districts to teach the people how horrible is the death by cancer, cancerphobia being one of the best agents for cancer cure. For all these reasons, it would seem advisable to print special lists of recognized cancer centers, to save the people from charlatantry and commercial clinics where personal profit comes first and the patient's health last.

DR. J. E. GENDREAU (Montreal, Canada): I wish to recall what the American College of Surgeons has recently done on this subject of cancer. They have established a special committee for surveying and classifying the institutions that are working on the cancer problem: cancer institutes, cancer laboratories, cancer hospitals, general hospitals in which cancer is specially treated, and diagnostic clinics. They propose to consider as "Class A Hospitals" only those hospitals in which there is a special cancer clinic.

I think it is a very important step, for the radiologists should consider the part they have to play in a general organization for the control of cancer. Recently, in some countries the surgeons have assumed the entire selection of different groups of men who are called upon to treat cancer. It seems to me that the radiologists should join with the surgeons to help one another, under the guidance of the best men in a given center, surgeons, radiologists, patholo-

gists, and general physicians. The direction of cancer treatment depends upon a group and in this group the radiologist is awarded the prominent position in many cases.

A. R. KILGORE, M.D. (San Francisco, Calif.): It does not seem to me that what the Society for the Control of Cancer has attempted to teach the public has been to any degree untrue. I think perhaps the Doctor has been reading the articles carried in the daily press by certain self-appointed guardians of the public health. The only thing we have had to take back has been our statement of five or ten years ago that cancer was known not to be hereditary.

But I do think we have to admit that the campaign which has been carried on by the American Society has gone somewhat stale. It has gone stale because we have not anything new to offer, and it is extremely difficult to secure effective publicity, as any one knows who has tried to do so, unless he has news to offer. I think the campaign of past years has been, on the contrary, quite successful, and the very reason why you are hearing the problem of the necessity of educating physicians discussed to-day so much is because the campaign, as carried on, has brought so many more patients early. The American Society has recognized the fact that its campaign had to be carried on along different lines, and I think I may state for the Society that its plans for the future agree with the ideas expressed here to-day—that our work both in educating the profession and in educating the public must be carried on definitely on the basis and with the help of cancer institutions—the group treatment of cancer. It is quite true that our medical schools have failed lamentably in training the profession for the diagnosis of early cancer and its treatment. When I graduated, not so many years ago, from a very fair medical school, I did not know the difference between a carcinoma and an ingrowing toe nail except

by name. We are trying our best to change that at the University of California. We feel that if we do not see to it that when our students leave us they know what the problem of an early breast lump is, their education will have been incomplete; and we are going to do that easier if we can follow up improved training in the medical schools with post-graduate training centered in cancer institutions.

ROLLIN H. STEVENS, M.D. (Detroit): I do not want you to understand that what I said about publicity was in criticism of the Society for the Control of Cancer. What I referred to was the information as given out by untrained doctors who know but little about cancer and who were appointed as lecturers in cancer campaigns to impart knowledge of cancer to the public. They certainly have given out a lot of misinformation about heredity and the surgical treatment of cancer. We have to modify our views on the subject of cancer from time to time. The public is not so much concerned with undemonstrated theories as with facts; *i.e.*, it is confused by such statements as, for instance, "Surgery is the only cure for cancer and, if taken early enough, all—or the greater proportion of—cases can be cured by this method," made to-day, while to-morrow that statement may be modified by one which says that cancers are probably not thus cured, and that X-ray and

radium will do much better work in certain cases.

DR. ULLMANN (closing): I think this discussion has brought out the necessity of meeting the cancer situation as I have outlined, *i.e.*, money for the cancer problem should be used for the problem as the whole. In one locality the public must be educated, in another the physicians, in another facilities must be furnished. What good does it do to have physicians who know how to treat cancer and patients who know enough to go to them, if there is nothing to treat these patients with when they get to the hospitals? The term "facilities" includes free beds for indigent patients. In closing I shall repeat what I said in my paper "The Necessity for Teamwork in the Treatment of Cancer," and what was so well brought out by Dr. Schmitz, that the problem of cancer can be met only by the trilogy of the surgeon, the radiologist, and the internist, placed equidistant from the pathologist as the center.

DR. QUIGLEY (closing): There is not much to be said in closing except to agree heartily with what Dr. Schmitz has said. I am sure he has "hit the nail on the head" when he says that those vast sums of money which have been expended in cancer research would have been much better spent on the education of physicians rather than in the effort to try to educate the public.

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# CASE REPORTS AND NEW DEVICES

## FATAL RESULT FROM USE OF UROSELECTAN

By J. A. RIEBEL, M.D., and FRANK A. RIEBEL, M.D.  
COLUMBUS, OHIO

Inasmuch as the literature to date indicates that intravenous pyelography is a harmless procedure, we feel it timely to present a case in which we feel that its use contributed to the death of a patient.

A. C., a white male, aged 53, was first seen by us on November 15, 1930. He gave a history of diabetes, and for two months had had a series of furuncles. Apparently both the diabetes and the furuncles had received indifferent treatment. For the past two weeks he had been running a fever, and had lost twenty pounds in weight.

Examination on the following day disclosed an obese white male, apparently quite ill. Temperature, 104°; pulse, 130; respirations, 28. There was a large furuncle over the seventh left rib, and another over the right kidney. Palpation gave a sense of resistance over the latter area, although a mass could not be definitely outlined.

X-ray examination of the chest was negative. Roentgenograms of the kidneys revealed moderate uniform enlargement of the left kidney; the right one was not visualized. However, while the lateral margin of the left psoas muscle was well defined, that on the right was very faintly visualized and appeared compressed medially. The lumbar spine was flexed to the left; diagnosis of probable perinephritic abscess was made.

Cystoscopy was performed, but because of intense inflammation, the ureters could not be located. As we had administered

uroselectan in three cases previously in our series without untoward effects, and as the diagnosis was still in some doubt, this procedure was thought to be indicated. We, therefore, injected two-thirds of the normal dose of uroselectan at 2 p. m. Forty-five minutes later the patient had a severe chill, and the temperature rose to 105°; pulse, 160 and weak. At the same time he became wholly incontinent. At 3 p. m. a roentgenogram disclosed the presence of a little of the opaque drug in the bladder, but its concentration was insufficient to produce a pyelogram. A blood count showed: red blood cells, 4,510,000; white blood cells, 18,475; hemoglobin 75 per cent. No urine was secured because of the incontinence. The patient lapsed into unconsciousness at 5 p. m. As it was feared that he would not react, he was operated upon at 7 p. m. An incision in the lumbar region over the right kidney disclosed an abscess containing two liters of thick pus, superficial to the muscles. A second incision released another liter from the region of the left midaxillary line. At 11 p. m. the temperature reached 107.8°, with no pulse. At 2 a. m. the patient died.

### SUMMARY

A case is reported in which the death of a patient, previously weakened by infection, was hastened by the use of uroselectan.

The case is interesting further in that the classical roentgenological signs of perinephritic abscess—lateral flexion of the lumbar spine, and unilateral effacement of the lateral margin of the psoas muscle—were simulated by an abscess located superficial to the muscular layers.

## ELIMINATION OF THE DARK ROOM IN PHOTOGRAPHY, ESPECIALLY AS APPLIED TO ROENTGENOLOGY

By H. FLECKER, M.B., F.R.C.S.,

Honorary Radiologist, Austin Hospital, Melbourne, Australia; Demonstrator in X-ray Anatomy, University of Melbourne

One becomes so accustomed to the disadvantages of dark rooms that they do not attract much attention, yet it is a fact that the actual necessity for such dark rooms, together with the necessary equipment, has deterred many medical men and dentists from installing X-ray apparatus. The dark room itself may have to be especially built or designed and this in itself implies added cost or additional rent. To avoid this, one frequently finds all sorts of places pressed into service as dark rooms, such as cupboards, cellars, attics, pantries, bathrooms, perhaps unsanitary and dirty and otherwise objectionable. Such makeshifts can be seen in every city and are extremely common in the country.

Rendering the dark room light-proof is frequently an expensive item, necessitating special blinds and curtains, ordinary window blinds being, of course, quite inadequate. Crevices, key-holes, ventilators, and other sources of light must be adequately covered, and to make the room light-proof there may be interference with proper ventilation. Of course, inadequate exclusion of light results in fogged films. To prevent accidental entry of light it is usual to lock the door during developing operations; in busy laboratories, expensive labyrinthine or revolving doors are fitted. As a rule, no outside person can gain admission to the dark room during the processes of developing or changing films, and thus it may be particularly inconvenient when stores, records, and other items are kept in the room.

It very rarely happens that owners are proud of the appearance of their dark rooms. The heterogeneous collection of tanks, bottles of chemicals, fixed cupboards, film hangers, and various other items does not make an attractive sight, whilst much of the dark room equipment is fixed and immovable, involving considerable expense if one is required to move to another location.

The menace to health of dark room operators is quite considerable owing to unhealthy surroundings, exclusion of light, and often inadequate ventilation. Rarely are special exhaust fans fitted as they involve additional expense, whilst cold floors and inadequate artificial heating also constitute disadvantages. Special acid-resisting flooring without any floor cloth is particularly cold in wintertime. It is, of course, quite impracticable to utilize electric radiators or the like.

Unless an expensive drying mechanism is installed, it takes many hours, especially in cold weather, for films to dry, and often films developed one day are not dry until the next.

All the various disadvantages just described have been overcome, and an apparatus has been built to eliminate the disabilities enumerated. A description of one model will serve as a type. The various parts may be noted in the illustration (Fig. 1).

The outside appearance shows the panels in the center above to consist of two doors, hinged on either side. On the right is the detachable drying chamber. Above, in addition to the switches for view lights and heater for the developing tank, are switches also for the drying compartment and a special heater for heating the tank compartment. A timer is placed on top of the cabinet.

The drying apparatus is on the right and is detachable. Above, a door connects it with the operating chamber. Suspended be-

neath the ceiling is a rack which can be pulled into the main operating compartment to receive the hangers after washing and viewing. When dried, the rack can be withdrawn by a door on the right-hand side of the cabinet. In the lower part of the cabinet is a special arrangement for drying the films by means of hot air. In the standard models designed, not only is the drying cupboard detachable, but also the hanger magazine and film store on the left. The operator, therefore, may install the central part alone, and at a later date add the drying cupboard as well as the hanger magazine and film store, as desired. The magazines for cassettes and films may be added separately, while the less elaborate tanks originally provided may be exchanged for more elaborate tanks, at any time.

Much care has been devoted to the design of the operating sleeves, which are perfectly light-tight, elastic, allow of the entry of the forearms with the greatest of ease, and permit of ready access to every part of the operating chamber. Any prejudice which may be conceived against their practicability is immediately dispelled upon examination. With the working slide in its normal position over the film magazine and the drip tray over the tank, there is no risk of fogging the films by light entering through the apertures of the sleeves when the forearms are not inserted.

When the sleeve panel doors are swung out, the interior of the cabinet is exposed. At the back are the rack and view box. On the left is the hanger magazine, divided into separate compartments of different sizes arranged horizontally to accommodate the various sizes of hangers. If desired, the magazine may be pulled farther into the working chamber.

On the floor of the operating chamber is the working slide, which slides either to the right or left. In its normal position it covers the cassette and film magazines, but

to uncover these parts, it can be moved either to the left beneath the hanger magazine or to the right over the developing tanks. Its lower surface is covered with lead to prevent stray X-rays reaching the films in the magazines. It serves as a work bench during the various loading and unloading operations and also preparatory to placing the films in the developing solution. Below, on the left, is a lead-lined cupboard for unopened film boxes, etc. In the middle, beneath the working slide, are two separate compartments. On the left is the magazine for the cassettes, divided into separate compartments of different sizes, arranged so that the cassettes may be inserted from without, in front, and removed from the interior of the chamber during working operations. The film magazine is situated immediately to the right of the cassette magazine and is similarly divided into separate compartments for films of different sizes. The spare space at the back serves as a chute for surplus wrappings and other papers, which are collected below in a special receptacle.

The whole unit is designed for use with special hangers which constitute a considerable improvement on those in current use. Much time is saved, as the films are slid into the hangers by a single movement without the necessity of clipping the four corners. The films do not bulge in the solutions, are just as easily removed by a single movement, and the hangers are specially designed to facilitate drying around the edges of the films.

The tanks are, in order from left to right, for (a) developing, (b) rinsing, (c) fixing, and (d) washing. All tanks (except the rinsing tank) are fitted with special guide-ways so as to provide the maximum accommodation for the films without the risk of abrasion, thus greatly economizing the photographic chemicals. Each tank is provided with a special pipe to which is fitted an ar-

arrangement for maintaining the solutions at a fixed level. The developing tank is provided with a heating device and an automatic solution agitator, as well as, when desired, a device for the automatic regulation

Variations of the above have been made according to the type or volume of work to be carried out. For instance, a design has been evolved for dental work, as well as a portable model. In addition to these, an-

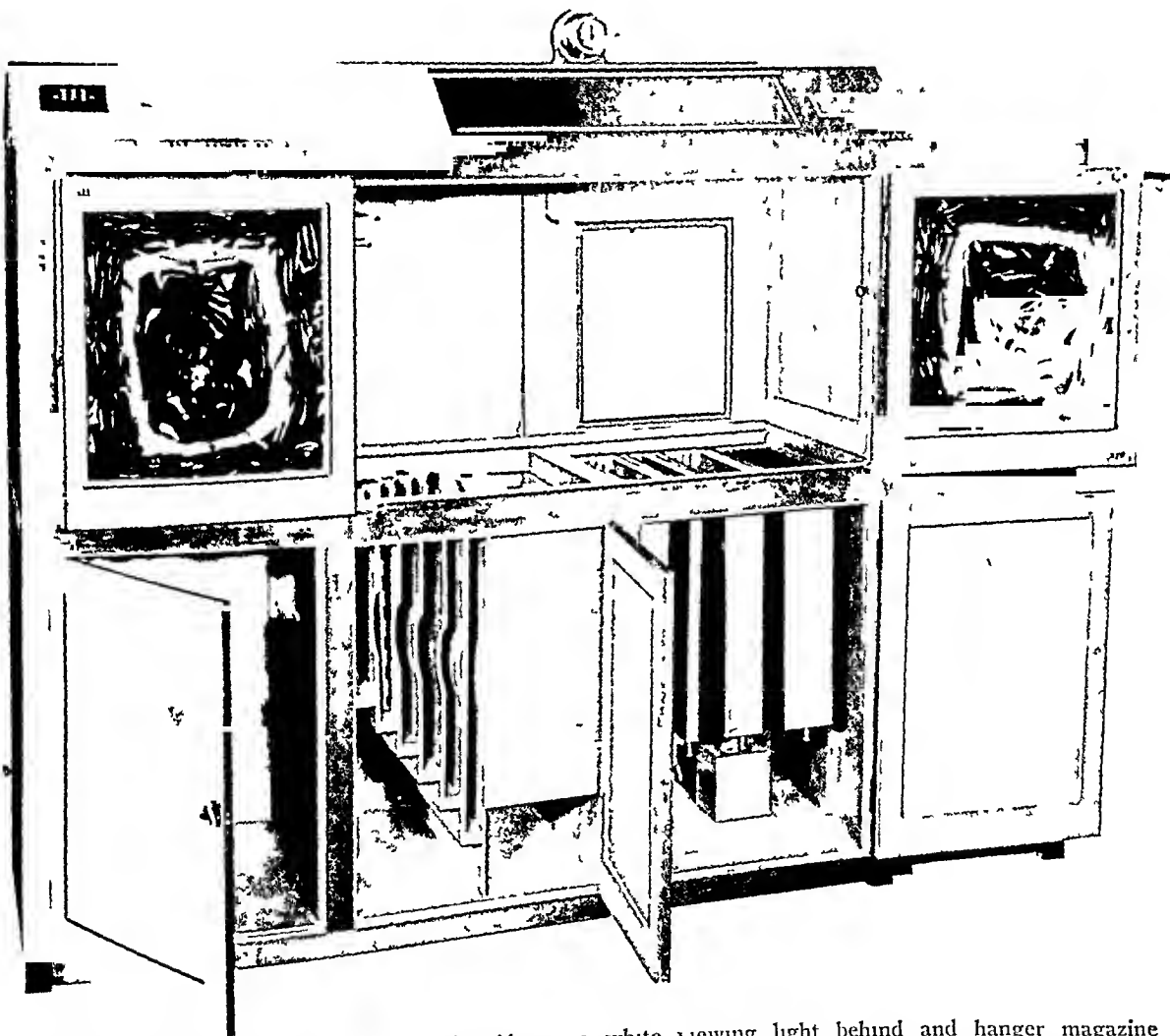


Fig 1 Interior of cabinet exposed. Above is white viewing light behind and hanger magazine on left. Below are lead-lined film store, cassette magazine, film magazine, paper chute, and tanks.

of temperature. There is also means for its automatic filling and emptying. The washing tank is provided with inflow pipe at the bottom as well as outflow, to permit of the use of running water. In addition, an arrangement is provided for heating the whole of the tank compartment. Over the tops of the tanks is fitted a drip tray to allow the water to flow back into the washing tank.

other model comprising the advantages of the tanks has been constructed for use in an already established dark room. One improvement deals with dental films, introducing the dental till as well as an entirely new type of dental hanger. The former is a small box divided into fourteen compartments, seven for the upper teeth and seven for the lower. The dental films themselves

are marked with the letter "L." The vertical and horizontal limbs lie parallel to one long and one short side of the film. When the exposure is made, care is taken to see that one short or long limb is applied to the edge of the teeth, thus indicating which is the edge of the tooth in the film. As each film is exposed, it is placed in proper serial order in the till. The dental hanger is built up in the same way as ordinary dental mounts, that is, of a series of spaces, seven in a row, four rows (one row for top set and one row for lower set of teeth, both repeated for duplicates). Prior to development, each film is taken out of the till in its proper order, and mounted in its proper place in the hanger, with the free edge of the teeth downwards in the upper set and upwards in the lower set. After the films are

developed and fixed they may be immediately viewed before the view box. There is no necessity to wait until the films are dried. The time-absorbing process of sorting is likewise abolished, as the films are already in proper order and may be at once placed in front of the view box for inspection.

To sum up, the entire system of dark room procedure may be revolutionized by this new unit. As yet, no operator who has worked with one prefers to revert to the old dark room methods, and X-ray departments in Australia are being designed entirely without dark rooms.

The units described have been designed and patented by Mr. John Bowker, of Melbourne, Australia, to whom the writer is indebted for the illustration.

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### PRESTON M. HICKEY MEMORIAL LIBRARY

Soon after the death of Dr. Preston M. Hickey a movement was started to establish some sort of a memorial to this leader in the field of roentgenology. After due deliberation the idea of a "Preston M. Hickey Memorial Library" was considered most feasible.

As Dr. Hickey had in his last years developed an organization for post-graduate training in roentgenology at the University Hospital, Ann Arbor, that department has been selected as the location for such a library.

Mr. W. W. Bishop, Librarian of the University, will accept and combine such a collection of books with the Medical Section of the general library, have them catalogued and listed and maintain an exchange in case of duplication. This can be done and still allow the library to be within the Department of Roentgenology for use of the staff

and students. Dr. Hickey had hoped to establish such a reference library.

The men trained under Dr. Hickey and those of his colleagues who know of the plans have signified their willingness to donate one or more volumes to this project. I am writing this letter in order that you may give it editorial comment if you so desire.

We feel that there are numerous friends of Dr. Hickey who would like to join in this effort but it would be rather difficult to reach them except through the medium of radiological publications. We are sending a letter to the Editor of each journal and asking that if he mentions the attempt which is being made in behalf of this memorial that he request any one who cares to donate to communicate with Mr. W. W. Bishop, Librarian at the University of Michigan, Ann Arbor.

[Signed] S. W. DONALDSON, M.D.

# EDITORIAL

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M. J. HUBENY, M.D. . . . . Editor

BENJAMIN H. ORNDORF, M.D. . . . Associate Editor

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## ANACHRONISTIC APHORISMS<sup>1</sup>

A beguiling and intriguing title, but so is the subject matter of this essay.

As a member of the infant Section, kaleidoscopic events have bewildered me in the same manner that others have been confused, annoyed, and somewhat paralyzed, because of the rapid changes affecting the humanities.

A well balanced life consists of a little bit of work, a little bit of play, and a little bit of sleep, and this philosophy is not the exclusive property of any given class or creed.

Medical men, as a whole, are self-sacrificing and unappreciated; usually their families are penalized by society because the breadwinner does not win enough of the material things to let them live in reasonable comfort, not to say luxury.

A new order of things has taken place; conditions and times are changing. Two factors have produced a somewhat sudden transition, creating a whirlpool which has engulfed pretty much the whole world. One has been the World War, which for a while produced an economic disaster—I say disaster because, in the ordinary course of events, the terrific economic adjustments which are now taking place would not have occurred during the period of a dozen gen-

erations, yet they are now crowded into the short span of one or two generations. It is true that eventually great economies will be effected; however, they have come so rapidly as to be actual cataclysms.

The other factor in these changing times is the so-called mechanization, which has liberated man-power from the most irksome, fatiguing, and depleting forms of employment. Mechanization in its finer sense includes the sciences; it explains rather tangibly what yesterday was considered metaphysical.

The basic sciences have established themselves firmly in routine medical work. The clinical thermometer and the stethoscope are accepted as quite necessary appliances. These simple tools have been rapidly aligned with intricate microscopes, spectrosopes, chemical apparatus, metabolimeters, electrocardiographs, and X-ray apparatus. In the final analysis, the aforementioned instruments give certain more or less definite information which, if properly collated, has the greatest value. So you can readily see that individualization still obtains; however, egotism and eccentricities are passé.

It seems incomprehensible that certain types of medical men deplore the use of refined diagnostic measures; however, it is more probable that they have in mind the abuse of these methods, and, to emphasize this, they unwittingly create the idea that inadequacy is the result of mechanization.

This same type of mind bemoans the passing of the family doctor. Well, has he really passed from existence or have we a new type of family doctor? The doctor of to-day is far better grounded in real values because of methods of precision. It is equally true that there is less sentimental at-

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<sup>1</sup>Chairman's Address, Section on Radiology, American Medical Association, Portland, Oregon, July 19, 1929.



tachment between doctor and patient; however, the attachment to-day is founded not on the emotional instability of the patient, but on the sounder service rendered to him, for which he is both grateful and appreciative.

So we have to-day the anticipated change in medicine. It has drifted from an eleemosynary institution, with its attendant inadequacy, to a real industry, to a commercial enterprise. In the past, we have resented the term "commercialism," but commercialism is a fair exchange of values at a chronological period of activity, which values are ever-changing and require frequent adjustments.

I am making no attempt to defend dishonest practices or persons—they are not even in the picture. I am of the sincere opinion that while the Hippocratic oath has been the guiding principle of conduct of the medical profession, it is equally true that men or groups of men in other pursuits have similar ideals and motives. There is one great difference which is quite obvious, namely, a violation of morals or conduct which jeopardizes life is the basest of crimes, hence the type of individual taking up medicine must be of the highest order.

Now, as to the cause or causes of the high cost of medical service. To roentgenologists it has become apparent that the day has passed when you can say to John, "Let me see your tongue," then feel his pulse and say, "Well, you'll live a hundred years"—and then John ungraciously drops dead two hours later. Medicine cannot be practised that way, because of laws demanding certain standards of efficiency and because your competitor will wear you out, as he uses or has the assistance of collaborators who use expensive apparatus to obtain certain data.

This naturally implies that a definite expenditure is necessary, and, in the case of those practising radiology, it is surprisingly and unavoidably high, varying from fifty-

five to sixty-five cents of every dollar earned.

Time will not permit a comprehensive analysis of this phase, as the ramifications are so wide; however, basically, it costs much to function in accordance with accepted standards.

Reverting back to the Hippocratic oath, there is one flagrant violation—it is a sad one, too, because the oft-practised custom of sending patients to lay technicians for radiological services is indulged in by supposedly honest and efficient physicians. Of course, it is needless to say that this practice is subversive to the best interests of the patient, besides being dishonest.

Roentgenology has in many instances reduced the intangible to the tangible, and, in the performance of this service, ponderous appliances are used, accompanied by a whirring and a buzzing, representing the ultimate in mechanization.

Efficiency is to-day a greater by-word than at any time in history and the medical profession is faced with serious problems, the solutions of which are attempted by lay people, who, properly inspired, make bequests of a religious, social, or medical nature. This is a benignant expression of benefaction. These zealots may be misguided, but sincere. Unfortunately, it often happens that the proper medical co-operation is not extended to guide such a benefaction, and it then acts as a boomerang, both to the medical profession and the benefactor.

One can readily see that medicine is becoming institutional, either as privately endowed, supported by taxation, or privately owned by the doctors themselves or jointly by doctors and lay persons. All such institutions have their sphere of activity and usefulness and should be recognized as permanent social structures with varying modifications.

As prosperity becomes more diffuse, the tax-supported institution will become grad-

nally extinct; pauperism, with its accompanying mendicity and shame, will greatly disappear.

Of course, the time factor is an essential one, and, necessarily, a constant analysis of the changing times is imperative.

Now, who can make this analysis—make it squarely and properly, certainly? Medicine is the hub of all activities and always will be, because life and all its activities pivot on health. This is a duty which could readily be absorbed by the American Medical Association, the parent body. Many of us hardly realize what a gigantic organization it is, or how extensive are the ramifications and numbers of its functions and activities. It consists of about 100,000 members; it publishes nine scientific journals, also a journal for public education in medical matters, namely, "Hygeia." It maintains a chemical laboratory for original work and analysis of nostrums. The Council on Pharmacy and Chemistry investigates and reports on medicines used by physicians. The Council on Medical Education and Hospitals conducts investigations and standardizes colleges and hospitals. The Bureau of Legal Medicine and Legislation does just what its name implies. Another activity is the Bureau of Health and Public Instruction. The good of the people is uppermost. The Department of Publications issues an index of medical literature.

There is nothing incompatible between sentiment and interest and it is only when one of these predominates that oppression begins. Since it is admitted that medicine is an industry, as previously mentioned, therefore, in accordance with the present trend, would it not be desirable for the sake of economic unity to establish another bureau, to be called the Economic Bureau, which would consist of three economists, three politico-economists, three sociologists,

three psychologists, three successful commercial appraisers, three statisticians and any other special group of highly trained and experienced men who could command good compensation, and who could analyze what social, economic, and educational changes are taking place and see where medicine fits in the scheme of things so that proper adjustments could be made in accordance with the changing times? In this way a well organized adjustment could be made from time to time without the usual great attendant financial distress.

Certainly medical men have brains and capacity to formulate modes of conduct and business, applicable to medicine, that would be equitable to all.

Of course, such an activity would entail considerable expense, and, to provide for this contingency, the doctors, if properly enlightened, I am sure would cheerfully contribute towards its maintenance.

It appears that there are too many societies—societies that have some real or imaginary reason for their existence. There has been a cleavage in medical activities; the formation of special societies has caused, in some instances, a supercilious attitude. Regardless of the original stimulus, their abolition should take place because of the reduplication of effort, the false expenditure of time and money with the minimum amount of return, and because the American Medical Association, as now constituted, covers all the activities both scientific and educational. Therefore it would be sane and sensible to initiate such a program. The savings thus effected would cheerfully be paid in the form of dues to the American Medical Association for essential activities.

I hope that these remarks will not be construed as iconoclastic or vindictive, but as food for modified thought and action.

tachment between doctor and patient; however, the attachment to-day is founded not on the emotional instability of the patient, but on the sounder service rendered to him, for which he is both grateful and appreciative.

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One can readily see that medicine is becoming institutional, either as privately endowed, supported by taxation, or privately owned by the doctors themselves or jointly by doctors and lay persons. All such institutions have their sphere of activity and usefulness and should be recognized as permanent social structures with varying modifications.

As prosperity becomes more diffuse, the tax-supported institution will become grad-

"Finally, it seems appropriate to suggest certain broad *conclusions and implications* from the findings of the study:

"I. The public owns the hospitals generally and will probably continue to carry the major burden of the fixed charges. The advantages of hospital facilities accrue in large degree to the entire public; hence the provision of hospital capital by the general public through taxation and voluntary contributions is an equitable procedure.

"II. The public might well exercise better control over the provision of capital investment. This may be accomplished through organized community approval of hospital construction programs, as well as through improved apportionment of patients and kinds of hospital service among existing institutions. Such a policy would release funds for other community purposes.

"III. Capital investment in hospitals should be held to an absolute or relative minimum consistent with effective medical practice. Such investment cannot be withdrawn for other purposes, nor is it desirable to restrict plant and equipment in such manner as to reduce the quality or amount of medical care. Consequently only by using the hospital facilities to their maximum capacity can the capital investment be most fully justified.

"IV. Capital investment in hospitals would be more effectively utilized if integrated with the total medical activities—preventive, diagnostic, and therapeutic—of the community.

"V. Fixed charges (interest and depreciation on invested capital) should be regarded as costs correlative with lay and professional services and with consumable supplies. They involve recurrent, though irregular, expenditures which must be met if hospital service is to be continued.

"VI. Hospital financing should attempt 'equitable' distribution of capital costs among beneficiaries (patients, medical professions, general public).

"VII. The allocation of fixed charges against the various hospital functions—health care, medical diagnosis and treatment, medical and nursing education, and medical and social research—would provide the basis for more effective financing of the various services.

"VIII. Hospital fees should be established with more regard to the total costs of services rendered, including fixed charges, even though it is not intended to recover these costs in full from all patients.

"IX. Knowledge of the total costs—by hospital authorities and by the public—is a prerequisite to the assessment of these costs against different groups of contributors or patients, or the removal of any or all of the burden. Certain groups of patients might consider hospital bills more reasonable if the element of interest and depreciation were properly appreciated.

"X. Fixed charges, even though borne by the general public, must be included in the records and reports of hospitals, if the costs and economies in one institution are to be comparable with those of another. It is unfair to the hospitals to omit these expenditures from the comparisons, and it is unwise for a community to regard 'operating costs' as the total costs of hospital service."

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### THIRD INTERNATIONAL CONGRESS OF RADIOLOGY

*Paris, July 26-31, 1931*

The following questions will be discussed at the Third International Congress of Radiology:

(a) Radiological examination of the mucosa of the digestive tube;

(b) Radiological examination of the urinary apparatus by excretion of opaque substances;

(c) Pre- and post-operative treatment

of cancer of the breast by radiation (recurrences and metastases excepted):

(d) Radiotherapy of inflammatory diseases:

(c) Diathermic electrotherapy of inflammatory diseases.

At a general meeting, all Sections being present, a thirty-minute lecture will be given on each of these subjects. All in attendance are invited to give the results of their experience on these questions, both by special communication and during the general discussion.

#### TRAVELING IN FRANCE

Those in attendance upon the Congress will benefit by a reduction of 50 per cent in the fare to and from the Congress over the French railways.

After the Congress, several tours at reduced rates will be organized to different regions of France, including visits to thermal and mineral watering places.

From the offices of the Congress particulars as to the above-mentioned reduced rates and railway fares, hotel rates in Paris, and the tours following the Congress will be sent to all members of the Congress who have paid their subscriptions. Upon application to the offices of the Congress, also, rooms in Paris during the Congress will be secured for members.

The subscription price to be paid by members of the Congress is 300 French francs. For persons belonging to the members' families who desire to participate in the events arranged for them, the subscription price is 50 French francs.

Summaries of communications designed to be read before the Congress must be in the hands of the officers in Paris before April 1, 1931. These summaries are not to exceed 400 words. They must be typewritten, and may be in the English, French, or German language.

The names of the five American delegates may be found in *RADIOLOGY*, November, 1930, page 599. Any of them will be glad to furnish information upon request.

Subscriptions are to be sent to the offices of the Third International Congress of Radiology, 122 rue la Boétie, Paris (8), France.

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#### FIFTEENTH ANNUAL CLINICAL SESSION OF THE AMERICAN COLLEGE OF PHYSICIANS

The Fifteenth Annual Clinical Session of the American College of Physicians will convene in Baltimore, Maryland, March 23-27, and in Washington, D. C., March 28, 1931. The organization holds this Session in Baltimore through the cordial invitation of the Johns Hopkins University School of Medicine, the University of Maryland School of Medicine, the Medical and Surgical Faculty of the State of Maryland, the Baltimore City Medical Society, and the further co-operative interest manifested by the various Baltimore hospitals and civic societies. Held in important medical centers, these Clinical Sessions constitute, perhaps, the most important post-graduate week in internal medicine each year. Those who attend the meeting will find ample interest in the way of clinical, laboratory, research, and historical work to repay them well for the time spent in making the journey. Dr. Sydney R. Miller, of Baltimore, President of the American College of Physicians, has prepared the program for the General Scientific Sessions, while Dr. Maurice C. Pincoffs, General Chairman, also of Baltimore, has arranged the program of clinics, demonstrations, entertainment, etc.

As an added feature of the Clinical Session this year, an additional day, March 28, will be spent in Washington, D. C., where a special program of clinics and inspection

tours has been arranged under the auspices of the Medical Departments of the U. S. Army, U. S. Navy, U. S. Public Health Service, and Georgetown University. Dr. William Gerry Morgan is acting as Chairman of the Washington Committee, and is being assisted by Admiral Charles E. Riggs, Surgeon-General of the Navy; General Merritte W. Ireland, Surgeon-General of the Army; General Hugh S. Cumming, Surgeon-General of the U. S. Public Health Service; Dr. William A. White, Director of the Government Hospital for the Insane; Dr. John A. Foote, Dean of the Medical Department of Georgetown University; Dr. Ales Hrdlicka, Director of the Department of Zoology of the National Museum; Dr. Roy Adams, Chief of the Medical Service at Mt. Alto Veterans' Hospital; Dr. W. H. Hough, President of the Medical Society of the District of Columbia; Dr. C. B. Conklin, Secretary of the Medical Society of the District of Columbia; Dr. George W. McCoy, Director of the U. S. Hygienic Laboratory, and Colonel Charles R. Reynolds, Commandant of the U. S. Army Field Hospital School of Carlisle Barracks.

The entire program of the Clinical Session is characterized by new subjects, new authors, and wide geographic representation. It is significant that the committees have attempted carefully to avoid repetition of subjects and authors, as has so often been the case in previous years, not only on the program of the American College of Physicians, but on the program of a great many medical organizations. On the general scientific programs there will be forty-five or fifty selected formal papers. Symposia on blood diseases, oxygen therapy, diseases of the liver, recent advances in endocrinology with particular reference to the newer work on suprarenal extracts, myocarditis, and several other subjects have been arranged. At Baltimore's many modern and excellently operated hospitals, clinics, ward-walks, laboratory demonstrations and the like will be

held. Johns Hopkins Hospital and School, under Dr. Alan M. Chesney,<sup>edical</sup> and a specially appointed committee,<sup>an</sup> place at the disposal of the College all <sup>ll</sup> facilities and offer a program of great<sup>h</sup> interest. Additional hospitals, such as Union Memorial Hospital, St. Agnes Hospital, at which Dr. Joseph C. Bloodgood does so much of his work, the Municipal Hospitals, and several of the more private institutions, such as the Howard A. Kelly Hospital, noted particularly for its radium activities, and the Sheppard and Enoch Pratt Hospital, which is one of the most modern dealing with psychiatric problems, and many others will provide programs of clinics.

Hotel headquarters will be at the Lord Baltimore Hotel, while general headquarters, at which the registration of members, commercial exhibits, and all general sessions will be held, will be the Alcazar, Cathedral and Madison streets, Baltimore. Transportation on the Certificate Plan of reduced fares will be available to all physicians and dependent members of their families from all parts of the United States and Canada. A special program of entertainment has been arranged for visiting ladies. The Convocation for the induction of new members as Masters or Fellows, will be held on Wednesday evening, March 25, and the Annual Banquet will be held on Thursday evening, March 26. The business meeting, at which reports of administration and elections for the new year will take place, will be held during the forenoon of Thursday, March 26.

Mr. E. R. Loveland, 133-135 S. 36th Street, Philadelphia, is the Executive Secretary of the College, and it is to him that requests for further information or programs should be addressed.

#### POST-GRADUATE COURSE

The Eighth Annual Post-graduate Course offered by the Otorhinolaryngological De-

of cancer of the breast by radiation (recurrences and metastases excepted);

(d) Radiotherapy of inflammatory diseases;

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As an added feature of the Clinical Session this year, an additional day, March 28, will be spent in Washington, D. C., where a special program of clinics and inspection

was in charge of Base Hospital No. 1 and later No. 41. On his discharge from the Army Dr. Belden became associated with Dr. H. M. Imboden, with whom he remained for three years, leaving Dr. Imboden to establish an office in Montclair, N. J. In 1923 Dr. Belden was appointed Director of the Radiological Department of New York Hospital, which position he held at the time of his death.

Dr. Belden was a member of the American Roentgen Ray Society, the Radiological Society of North America, the American Medical Association, New York State and County medical societies, the New York Roentgen Society, and the Clinical Roentgen Society of New Jersey. He was one of the early members of the New York Roentgen Society and was always among its active workers, being deeply interested in its advancement, and serving the Society in all its offices—as Secretary, Treasurer, Vice-president, and President.

While not a prolific writer, Dr. Belden had contributed considerable to the literature, some of his work being outstanding. Among his contributions were: "Some X-ray Findings in Lobar Pneumonia"; "Roentgenological Consideration of the Mediastinum"; "Bone Diseases"; "Secondary Evidence of Gall-bladder Disease"; "The Fifth Lumbar Vertebra Roentgenologically Considered"; "Interthoracic Tumors and Their Treatment," and "Further Study of Osteitis Deformans and its Therapeutic Treatment."

Despite his comparative youth Dr. Belden ranked high in his specialty and gave promise of a brilliant and useful future. His untimely death leaves a vacancy not easily filled and must be regarded as a distinct loss to the profession. As a diagnostician he was particularly keen, many of his interpretations being worthy of men much older in the field of roentgenology. His aid and advice were often sought and al-



WEBSTER W. BELDEN, B.S., M.D.

ways cheerfully given. Whatever he did was done wholeheartedly, and whether he worked or played, it was always with keen interest and enthusiasm. He played hard, but this meant that he worked the harder to compensate for his pleasure.

To be able to call Dr. Belden a friend was a privilege. To know him was to love him, but to be his friend was an honor. In the true sense of the word, Dr. Belden had few "friends," but for these no service was too hard, no sacrifice too great. Those who knew him well will always cherish his memory, for

"Not silent are the hallowed dead,

A richer eloquence survives.

We have from those who've gone ahead

The inspiration of their lives."



## RESOLUTIONS

The New York Roentgen Society was glad to learn of the untimely demise of Dr. W. Belden, one of its most active members, who has served it loyally as a member and in the capacity of Secretary, Treasurer, and President; who has made important contributions to the science of roentgenology, and from whom it felt privileged to expect a great deal more in the future of the specialty; who upheld the standards of his vocation as set forth by his grandfather and father, both of whom were honorable members of the medical profession.

The Society feels his loss very keenly and therefore

*Resolves*, to spread upon its minutes these sentiments of its love and respect for the departed member, and further

*Resolves*, to express to his widow, his children, his aunt, and his many devoted friends its most heartfelt sympathy, and further

*Resolves*, that in token thereof a copy of these Resolutions be forwarded to the *American Journal of Roentgenology and Radium Therapy*, and to *RADIOLOGY*; another to his widow and children, and another to his aunt.

H. M. IMBODEN, M.D.

L. JACHES, M.D.

J. REMER, M.D.

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CLAUDE E. QUINN

Dr. Quinn, whose death occurred on January 2, 1931, had been a member of the Society since 1921, and leaves many friends both among radiologists and Indiana physicians. He was born in Cutler, Indiana, and spent his lifetime in his native State. He was a graduate of the State University and began the practice of medicine in the town of Burlington. During the World

War he served as First Lieutenant in the Medical Corps. For the past ten years he had practised in Terre Haute. Dr. Quinn was a member of all his State and local medical societies.

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## BOOK REVIEW

PROCEEDINGS OF THE NINTH ITALIAN CONGRESS OF MEDICAL RADIOLOGISTS, TORINO, ITALY, MAY 20-22, 1930. Published by Societa Italiana di Radiologia Medica. (Press) Immacolata Concezione, Modena, Italy, 1930. Pages 352.

Section I of this work is devoted to a consideration of the roentgenographic anatomy of the skull and a discussion of the roentgenographic signs associated with tumors of the base of the skull.

The roentgenographic anatomy of the skull is considered by Prof. Umberto Nuvoli, who has correlated in an excellent manner the anatomic and roentgenographic features of the skull. The various accepted roentgenographic positions are discussed and the anatomic structures revealed by each are described and illustrated by many roentgenograms and drawings.

Dr. Arrigo Montanari has written a very comprehensive review of the important literature relating to the roentgenographic signs of tumor at the base of the skull, and his paper represents one of the few monographs in which one may find a summary of all the significant roentgenologic data. The various parts of this section are arranged as follows: (1) general radiologic signs of intracranial tumors; (2) general roentgenographic technic; (3) the anterior cerebral fossa; (4) the middle fossa—(a) endosellar tumors, (b) extrasellar tumors (suprasellar, parasellar, subsellar, presellar, and retrosellar), and (5) the posterior cerebral

fossa. The entire subject is excellently illustrated and represents a distinct contribution to the roentgenologic literature pertaining to the skull.

It is to be regretted that a bibliography of the literature reviewed is not presented for the benefit of those interested. It is unfortunate also that this discussion is available only to those familiar with the Italian language, for it contains much of interest to all roentgenologists.

Section II, by Dr. G. Bignami, concerns radiotherapy in diseases of the blood. The author considers the effects of roentgen rays on (1) leukemias (myeloid and lymphatic), (2) Vaquez's disease, (3) aplastic myelosis, (4) pernicious anemia, (5) malignant granulomatosis, (6) Gaucher's disease, (7) Mikulicz's disease, (8) chloroma, (9) myeloma, (10) lymphosarcoma and lymphosarcomatosis, (11) systemic infections of the lymphatic glands, (12) primary splenomegaly (Banti's, Gamma's disease, splenomegalic hemorrhagic icterus), and (13) hemorrhagic diatheses.

Emphasis is laid upon the statement that treatment should be individualized and not schematized and that the patient should

always be under rigorous clinical control. Roentgenotherapy is the method of choice for chronic leukemias, granuloma malignum, lymphosarcoma, and polycythemia. It is of no value in acute leukemia's and in chloroma. In the other groups expert treatment may give worthwhile results in selected cases.

This paper is well worth reading in the original, as it presents succinctly but in a manner not suitable for abstracting a conservative point of view derived from both an evaluation of the literature and the author's own personal experience.

It seems strange that the radiotherapy of pernicious anemia should be included in this review in the face of the well known value of medical treatment with liver, etc. A slight improvement in this paper would be the inclusion of the complete references instead of merely the names of the authors cited.

The reports by L. Siciliano (pages 315-343) on some comments on the problem of radiotherapy of diseases of the blood, and by A. Ferrata (pages 345-352) on blood diseases and roentgen rays, supplement by detailed discussions certain points brought out in Bignami's paper.

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**Polarization Measurements on the Human Skin: A Contribution to Basedow's Disease and its Radiotherapeutic Estimation.** H. Regelsberger. *Fortschr. a. d. Geb. d. Röntgenstr.*, June, 1930, XLI, 950.

Physiologists are acquainted with a skin reaction which is closely related to skin metabolism: the variable electrical charge of functioning cells is recognized by a change in the measurable bio-electric currents. A. D. Waller, an English physiologist, first pointed out the relations between the intensity of metabolism and electric energy, showing that with proper methods of irritation of the skin or any other living tissues, "blaze-currents" may be obtained and registered as an expression of latent or mobilized metabolic energy. Two different kinds of electrical phenomena may be registered from the skin: (1) directly conductible, permanent, or rest-currents; (2) so-called polarization currents, which are obtained following charging of the skin from a direct current potential. The latter are more easily tested and recorded and were used in these experiments. These currents are influenced by any change of the permeability of cell membranes for the exchange of ions. Mechanical, thermic, electric influences, and ultra-violet irradiation produce such

permeability changes. Registering such currents on a large number of patients continually over many days, one obtains curves which show fluctuations comparable to temperature curves, with physiologic elevations and recessions. These are considered to be related to vegetative transformations during assimilation of food. A permanently low curve is found in all diseases accompanied by vagotonia, especially, for instance, bronchial asthma and the post-encephalitic periods. An elevated level of these curves is observed accompanying all cases of sympathicotonia, especially in true Basedow's disease and Reynaud's disease. It is of interest that in the latter the elevation is found only when testing for these currents on the affected extremities, not on the unaffected, while in the former, any portion of the skin participates. In hyperthyroidism (Basedow) the curves may well be used as indicators for the radiotherapeutic results, and, as a whole are more reliable than basal metabolism readings, and constitute valuable additions thereto.

A brief general discussion of these biologic skin phenomena is added, and attention drawn to many rather puzzling problems in connection with this work. Characteristic curves are reproduced.

HANS A. JARRE, M.D.

## GYNECOLOGY AND OBSTETRICS

The Development of Gynecological Roentgen Therapy during the Past Ten Years in the Second University Clinic for Women at Budapest. Felix Gál. *Strahlentherapie*, 1930, XXXVII, 623.

Cases of uterine bleeding during the climacteric are most suitable for roentgen treatment; the percentage of cures reaches almost 100. Before roentgen sterilization, dilatation and curettage are done in each case. Uterine fibroids are either operated on or treated by roentgen rays. During 1929, ninety-two women had the fibroid removed and fifty-one were irradiated. All cases in the climacteric age or women suffering from heart, kidney, or lung disease, or following a long period of bleeding, and fat individuals go to the roentgenologist.

In women under 40 or cases in which there is a suspicion of a submucous degenerated, or large fibroid, ovarian tumor, tumor of the adnexa, or in which the diagnosis is obscure, surgery is given the preference. Cancer of the uterus is operated on only if the case is not advanced and only if there are no other complications.

The remaining patients are treated by radium and X-rays in combination. In a number of cases of sarcoma of the female genital organs, five-year cures were obtained. The treatment of the remaining gynecological conditions amenable to roentgen irradiation does not deviate from that customary in the majority of clinics.

ERNST A. POHLE, M.D., Ph.D.

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The Pelvis and Maternal Mortality. Florence Stoney. *British Jour. Radiol.*, September, 1930, III, 426.

The author's article is well illustrated with photographs and roentgenograms of three types of female pelves: (1) from the Bushmen tribe of South African women, whose pelvic inlets were all found to be round (these individuals all wear scanty clothing and have, therefore, an abundance of ultra-violet radiation); (2) the oval type of pelvis of modern

British women (who, during growth, receive a limited amount of ultra-violet), and (3) the flattened pelves of the rickety and tri-radiate beaked pelves of the more pronounced osteomalacia type (in which the women, during growth or later in life, have little or no ultra-violet radiation).

The writer then emphasizes the necessity for abundant Vitamin D for all females during both growth and adult life, as a means of reducing maternal mortality.

J. E. HABBE, M.D.

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Peculiar Alterations of Ossifying Nuclei of a Syphilitic Fetus. Luigi De Vecchi. *La Radiologia Medica*, May, 1930, XVII, 575.

This is a radiologic and histologic study of the metatarsus of a syphilitic fetus. The author advances a hypothesis which could explain certain anomalies of the skeleton found later in the area in which development is completed.

L. MARINELLI.

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Diagnosis and Therapy of a Case of Hydrops Tubæ Profluens by Salpingography. O. Polano. *Strahlentherapie*, 1930, XXXVII, 619.

In a woman, 38 years of age, the fifth pregnancy had to be interrupted because of extreme hyperemesis. Since she was also suffering from severe depression, particularly during menstruation, the uterus was removed and the tubes transplanted into the vaginal wound. After a year she returned, complaining of vaginal discharge, severe pain in the back and lower abdomen, accompanied by fever. Examination revealed a tumor about the size of an apple in the right posterior fornix. Assuming that this was an abscess, a needle was introduced and an opaque exudate could be obtained. For the days next following, a dark, thick discharge from the vagina was noticed. Examination revealed a small fistula in the abdominal end of the vagina. The presence of a fistula between ureter and vagina could be excluded. A cav-

ity into which the fistula led was filled with 5 c.c. of an iodine preparation. The roentgen examination permitted the diagnosis of a hydrosalpinx of the right tube following vaginal hysterectomy. The right adnexa were removed, also the appendix, and the patient recovered.

The author concludes that even after removal of the uterus, salpingography can be used for differential diagnosis.

ERNST A. POHLE, M.D., Ph.D.

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**Roentgenological Manifestations of Syphilis in Infancy and Early Childhood.** John E. Heatley. *Jour. Oklahoma St. Med. Assn.*, September, 1930, XXIII, 300.

Congenital syphilis is more likely to show bone changes than acquired syphilis and usually several bones are involved. The most common sign during infancy is epiphysitis, which is present in from 70 to 90 per cent of the cases of congenital syphilis in the first three months of life. Later in life, congenital syphilis shows the same bone changes as acquired forms, the most common manifestation being a periostitis. Syphilis is essentially a bone-producing disease, though there may be areas of destruction as well.

W. W. WATKINS, M.D.

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**The Scientific and Experimental Foundations of Temporary Roentgen Amenorrhea.** Hermann Wintz. *Strahlentherapie*, 1930, XXXVII, 407.

The author discusses in detail the present status of our knowledge concerning temporary sterilization. The article does not lend itself well to abstraction, but it is recommended for study in the original. In conclusion, it is stated that the technic of temporary sterilization has been developed to the same degree of accuracy as any other medical technic. It has been proven that no injury to the patient results from the performance of temporary roentgen sterilization. There are no changes in metabolism, in the skin, in the psyche, in the glands of internal secretion,

in the condition of the genitalia, or in the sexual life. The method is, therefore, a valuable addition to our therapeutic procedures.

ERNST A. POHLE, M.D., Ph.D.

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**Means for an Exact Dosage in Carrying Out Temporary Roentgen Amenorrhea.** Th. C. Neeff. *Strahlentherapie*, 1930, XXXVII, 567.

The author discusses the problem of dosage in the X-ray treatment of women for the purpose of temporary sterilization. It is essential that the correct dose be applied, determined accurately within a small percentage. This requires the use of a reliable measuring instrument which integrates the dose; the chamber must be placed in the vagina; one large front and one large back field must be used, and the two tubes should run simultaneously. This arrangement prevents errors in dosage due to postural changes of the patient.

ERNST A. POHLE, M.D., Ph.D.

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**Amniography (Preliminary Report).** Thomas O. Menees, J. Duane Miller, and Leland E. Holly. *Am. Jour. Roentgenol. and Rad. Ther.*, October, 1930, XXIV, 363.

"Amniography" is proposed as a name for the artificial increase in density of the amniotic fluid to give contrast to fetal soft parts and placenta. This contrast is obtained by the injection of a 1 to 1 solution of U.S.P. strontium iodide through the anterior abdominal wall, with a small lumbar puncture needle. The actual concentration is about 0.75 gm. per cubic centimeter. In 21 cases injected there have been no injurious or toxic effects to the mother or fetus in normal pregnancies. The rate of absorption of strontium iodide was rapid, the fetal contours being lost at about twenty-four hours. The authors conclude that amniography may be of value in the diagnosis of placenta prævia, and in determining the exact relation of the placenta to the cervical canal. In a small percentage of cases the sex of the fetus could be definitely stated.

J. E. HABBE, M.D.



**Uterine Fibroids: Analysis of One Thousand Consecutive Cases.** Joseph Cohen. *Southern Med. Jour.*, October, 1930, XXIII, 875.

This is an analysis of one thousand consecutive cases of fibroids treated at the Charity Hospital of New Orleans, dating from July 1, 1929. Of these, 103 patients were white and 897 were colored. Only 13 of these were treated with radium, the results not being stated; 695 patients were operated upon, with a mortality of 4.6 per cent. One case had a fibromyosarcoma, and two cases had cervical cancers.

(*Abstractor's note:* This article is thus briefly mentioned to show that the radiation treatment of fibroids has not yet gained the recognition which many radiologists think it should have.)

W. W. WATKINS, M.D.

### HEART AND VASCULAR SYSTEM (DIAGNOSIS)

**Rupture of the Aorta.** C. J. Tidmarsh. *Canadian Med. Assn. Jour.*, September, 1930, XXIII, 416.

This is an interesting case report in which the patient lived for twelve days following a rupture of the descending aorta, 3 cm. in length, and died two days after the onset of right-sided hemiplegia, the result of thrombotic infarct in the brain.

L. J. CARTER, M.D.

**Four Cases of Aneurysm.** H. E. MacDermot. *Canadian Med. Assn. Jour.*, August, 1930, XXIII, 248.

Detailed reports of the diagnosis and termination of four cases of aneurysm are given. Each case illustrates two cardinal characteristics of aneurysm, namely, the great difficulty attached to its diagnosis and prognosis, and its sudden catastrophic ending. The location of the aneurysm and the cause of death varied. In three of the cases the Wassermann reaction was characteristically positive, while in the other case it

was doubtful. The difficulties of diagnosis in each case were marked.

L. J. CARTER, M.D.

**The Uncoiled Aorta: Part II.—The Pathologic Aorta.** David S. Dann. *Am. Jour. Roentgenol. and Rad. Ther.*, August, 1930, XXIV, 154.

Four types of heart and aortic disease are discussed, *viz.*, arteriosclerotic, syphilitic, hypertensive, and rheumatic. The character of the uncoiled aorta in these conditions is described and illustrated. In the arteriosclerotic type of aorta, the author shows teleoroentgenograms which present a distinct elongation and tortuosity. There is a marked convexity at the base of the supracardiac shadow to the right, just above the right auricle. A similar convexity is noted in the descending aorta to the left of the supracardiac shadow. In the syphilitic aorta a tremendous elongation and tortuosity is shown, with an enlarged heart, horizontal in position. It is in the syphilitic aorta that one can demonstrate the greatest dilatation and uncoiling, measured by the author by taking the transverse and vertical measurements of the entire arch in the left anterior oblique projection. In hypertensive heart disease, the author notes a superiority of the left antero-oblique position over the frontal view, which clearly demonstrates alterations in the aortic tube. While one expects to find the aorta definitely uncoiled in high blood pressure, the author has encountered several cases of high blood pressure, associated with a parenchymatous nephritis, in which no aortic abnormality could be demonstrated. In rheumatic heart disease, the absence of pathologic uncoiling of the aorta is quite conspicuous.

The author concludes that the aorta may be pathologically uncoiled as a result of senile sclerosis, hypertensive heart disease, and syphilis, but the roentgen appearance of the aorta, *per se*, cannot be used for differential diagnosis. The cardiac configuration may be of some aid. The determination of a pathologic uncoiled aorta is but the posi-

tive demonstration of a volumetric change. The roentgen observations should always be correlated with those clinically determined.

J. E. HABBE, M.D.

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**The Roentgenologic Diagnosis of Coarctation of the Aorta (Adult Type).** Walter W. Fray. *Am. Jour. Roentgenol. and Rad. Ther.*, October, 1930, XXIV, 349.

The author believes that he has ample justification for stating that "the roentgenologist has an excellent opportunity to make this diagnosis, entirely unaided by clinical or laboratory data."

The roentgen findings in coarctation of the aorta (adult type) are sufficiently definite and characteristic to establish the diagnosis by this means alone. The simple roentgen technic consists of roentgenoscopic examination, a postero-anterior film and a left postero-anterior oblique film. The direct roentgen signs of coarctation relate to the defect in the aortic arch in the postero-anterior and left anterior oblique views. The indirect signs, left ventricular hypertrophy and dilatation of the ascending aorta, relate to the obstruction of the blood flow through the aorta and the rib erosion to the collateral circulation which results from such obstruction. The direct sign of the defect in the arch and the indirect sign of rib erosion are of the greatest diagnostic importance. Two cases are reported which illustrate the roentgenologic features necessary for establishing the diagnosis.

J. E. HABBE, M.D.

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**Comparison of the Methods Used for Estimating the Size of the Heart.** Sinclair Luton. *Southern Med. Jour.*, August, 1930, XXIII, 681.

In diagnosing chronic heart disease the most important single determination is the size of the heart. This can be done in three ways, namely, by locating the apex beat, percussion, and the X-ray. The X-ray is employed extensively to depict the heart by means of the fluoroscope, orthodiascope, ordinary and two-meter films, the latter giving almost a true picture of the heart's size, if

the technic is proper. There are several possibilities of error in the X-ray technic, so that in clinical work an allowance of from 1 to 2 cm. should be made. Physical methods should always be used whether or not X-rays are employed, and there are certain cases in which physical methods alone can determine the size of the heart. This group includes the patients with small left-sided pleural effusions. By perfecting one's self in percussion technic, the heart can be outlined very accurately.

W. W. WATKINS, M.D.

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**The Excitatory Process Observed in the Exposed Human Heart.** Paul S. Barker, A. Garrard Macleod, and John Alexander. *Am. Heart Jour.*, August, 1930, V, 720.

The authors have made classical physiological observations concerning the transmission of impulses within the conducting system of a living human heart in a young man upon whom a pericardiostomy was performed for suppurative pericarditis complicating a streptococcus pneumonia.

Various points on the surface of both ventricles were electrically stimulated with an ingenious electrode introduced through the surgical opening. Simultaneous electrocardiograms recorded the resulting spread of impulse. Existing theories as to the point of origin of extra-systoles in right or left ventricle, and of the anatomical site of lesions involving a single branch of the His-bundle based upon electrocardiographic evidence, are completely reversed in the conclusions drawn from these well planned and carefully executed experiments.

FRED JENNER HODGES, M.D.

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**The Roentgenologic Appearance of a Thrombosis of the Left Auricular Appendage.** Julian Arendt. *Röntgenpraxis*, Sept. 15, 1930, II, 838.

The roentgenologic demonstration of thrombi in the heart is very rare; only a few such cases have been described. A case is re-

ported by the author of a patient in whom the left auricular appendage was filled by thrombotic masses. The roentgenologic examination demonstrated a peculiar change in the outline of the left heart; especially in that the region of the left auricle was very prominent and appeared denser than the rest of the heart. Dilatation of the left auricle was diagnosed roentgenologically, but an autopsy proved the deformity to be caused by a large thrombus in the left auricular appendage.

H. W. HEFKE, M.D.

### HODGKIN'S DISEASE (THERAPY)

A Case of Lymphogranulomatosis Clinically Cured for Four Years. Menna ten Doornkaat-Koolman. *Strahlentherapie*, 1930, XXXVIII, 147.

The history of a boy, eleven years of age, who was treated for Hodgkin's disease, beginning in 1924, is related in detail. At that time, the occipital, cervical, and inguinal glands were involved, as well as the mediastinum. Between January, 1924, and May, 1925, four series of X-ray deep therapy treatments were applied, combined with prolonged stays in the mountains. Since 1926, the patient has been clinically cured, has physically developed well, and is capable of working as a clerk at the present time.

ERNST A. POHLE, M.D., Ph.D.

Results of Treatment by Autogenous Gland Filtrate in Hodgkin's Disease. Edward M. Hanrahan, Jr. *Ann. Surg.*, July, 1930, XCII, 23.

A brief review of the etiologic theories concerning the nature of Hodgkin's disease is presented. The author is concerned especially with the immunological method of Wallhauser and Whitehead. The procedure consists of the use of autogenous, bacteria-free extracts made from the specific lesions of the disease. This extract was given subcutaneously in small, usually increasing doses, and at frequent intervals. Up to May 21, 1929, Wallhauser reported eleven treated cases, in which

five improved, five died (from all causes), and in one treatment was discontinued.

The author treated nine cases of Hodgkin's disease. In certain instances, radium and roentgen-ray therapy were used at various times during the course of the disease. He reports that five of the nine cases treated by him have died of the disease. Three of these five had transitory remissions. Two have returned to irradiation treatment, although one seems slightly improved under the filtrate treatment. Two were apparently unaffected by treatment after ten- and six-week periods, respectively.

F. B. MANDEVILLE, M.D.

### MASTOID (DIAGNOSIS)

Procedure for Obtaining Symmetric Images of the Mastoids—Oblique, Antero-posterior, Sagittal Incidence. Carlo Crespelani. *La Radiologia Medica*, May, 1930, XVII, 558.

This is a description of a simple method of radiological analysis of both mastoids projected on films  $13 \times 18$  cm., with two views. The accessories employed are very simple and easy to make. They consist of: (1) A cap of ordinary fabric marked for the exact determination of the medium sagittal axis of the skull; (2) a goniometric glass with lines at 52 degrees for the orientation of this axis, with respect to the plane of the film; (3) a centering bridge which prevents lateral displacement of the point of rotation of the head. The technic is essentially the combination of the Worms-Bretton and Arcelin-Garlard methods, and is very simple to follow.

L. MARINELLI.

### MEASUREMENT OF RADIATION

The Penetrating Radiation in the Atmosphere. M. H. Schulze. *Strahlentherapie*, 1930, XXXVI, 270.

The penetrating rays found in the atmosphere, their nature, properties, and measurement, are discussed in this article, which concludes with a brief chapter regarding their bi-

ological effects. The paper is well illustrated by photographs and diagrams and should be studied in the original, since it offers valuable information on a very interesting subject.

ERNST A. POHLE, M.D., Ph.D.

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**Measuring of the Polarization and Radiation Stimuli. (Second Communication.) Ways and Aspects of a Bio-electric Radiation Dosimetry.** H. Regelsberger. *Strahlentherapie*, 1930, XXXVII, 177.

The author determined the polarization of the skin in irradiated and non-irradiated areas. He found a definite difference in the readings if comparing unexposed, lightly exposed, and heavily exposed fields. (The apparatus has been described in *Fortschritte a. d. Geb. d. Röntgenstr.*, June, 1930, XLI, 950.) It is assumed that the cell permeability is one of the most important factors in the observed phenomenon. The possibility of using polarization measurements of the skin in radiation dosimetry is discussed.

ERNST A. POHLE, M.D., Ph.D.

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### OFFSPRING, EFFECT ON

**The Animal Experimental Foundations of the Problem of Late Injuries Due to Roentgen Rays.** Ludwig Nürnberger. *Strahlentherapie*, 1930, XXXVII, 432.

The entire recent literature dealing with investigations of the effect of roentgen rays or radium on the offspring is critically reviewed in this article. The author, who has done considerable research of his own in this field, concludes that, up to date, no positive proof has been offered as to a late injury to the offspring following irradiation of the parents. The experiments of Muller on *Drosophila* can not be interpreted in that sense either. From experiments of other investigators, it appears that the effect of irradiating the generative organs of *Drosophila* does not influence the offspring any more than about fourteen days following the exposure.

ERNST A. POHLE, M.D., Ph.D.

**The Development of Children Following Temporary Roentgen or Radium Sterilization of the Mother.** H. Naujoks. *Strahlentherapie*, 1930, XXXVII, 572.

The history of six children is related, who were born of mothers after the latter had undergone temporary sterilization by roentgen rays. Although a few abnormalities were observed in these children, no definite proof of radiation injury could be established. Since temporary roentgen sterilization is being carried out only in rare cases, the author urges all clinicians to publish the records of children born of such patients.

ERNST A. POHLE, M.D., Ph.D.

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**Injuries to the Gonads Not Caused by X-rays but Due to Extraneous Factors.** H. Stieve. *Strahlentherapie*, 1930, XXXVII, 491.

It is pointed out in this paper that there are many indirect factors which may injure the germ cells, for instance, excessive use of alcohol, caffeine, or toxins during infections. Nutritional factors, particularly too much fat in the food, have long been known among farmers to be detrimental to fertility. The climate can also play an important rôle in this connection. In cases in which not all germ cells have been destroyed, the newly formed cells are healthy and furnish healthy offspring. The only danger which lies in the injury of the germ cells *via* a systemic disturbance, is a complete sterilization. This chance is greater in the female than in the male. According to the present status of our knowledge, there is no danger of injury to offspring from germ cells coming from previously injured germ glands. Since the anatomical picture of injuries in germinative tissue, due to extraneous causes, is identical with that following roentgen irradiation, it is left to the reader to draw his own deductions.

ERNST A. POHLE, M.D., Ph.D.

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### PAGET'S DISEASE (DIAGNOSIS)

**Contribution to the Question of Atypical Bone Changes in Osteitis Chronica Deformans.**

mans Paget. G. Bastian. *Röntgenpraxis*, June 15, 1930, II, 569.

The typical case of Paget's disease shows a characteristic roentgen picture; there are, however, instances in which a definite diagnosis is difficult or impossible. Recently there has been an attempt to separate osteodystrophia fibrosa into several groups: morbus Paget, Recklinghausen, leontiasis ossea, hyperostosis diffusa. Osteitis deformans Paget and osteitis fibrosa Recklinghausen must to-day be considered as separate diseases. The roentgenologic differential diagnosis is gone into, and an atypical case of Paget's disease is described.

H. W. HEFKE, M.D.

Discussion of Some Cases of Osteitis Deformans (Paget's Disease). Ettore Conte. *La Radiologia Medica*, August, 1930, XVII, 940.

The author has followed, for several years, some cases of Paget's disease. He was able to observe alterations of the base of the skull, and the effect of irradiated ergosterol in a patient having a fracture. Some peculiarities were also noted during the development of the disease in syphilitic patients, and a clear picture is given of the errors in which the radiologist may concur when dealing with fractures of the bones affected by Paget's disease.

L. MARINELLI.

## PROTECTION

Thicknesses of Lead Protection in the German Ordinances Regarding Protection against Radiant Energy. J. H. van der Tuuk and W. Hondius Boldingh. *Fortschr. a. d. Geb. d. Röntgenstr.*, June, 1930, XLI, 965.

Concerning the Question of Protective Lead Thicknesses in the International Recommendations and the German Ordinances

Regarding Protection against Radiant Energy. R. Glocker. *Fortschr. a. d. Geb. d. Röntgenstr.*, June, 1930, XLI, 967.

These two technical papers present some discrepancies in the international and German rules for protection against radiant energy. Glocker evidently arrives at reasonable, compromising conclusions, and gives a corrected curve from which the lead thicknesses necessary for protection with variable potentials may easily be read. This curve, however, should be used only in connection with the complete recommendations and not under any arbitrary conditions.

H. A. JARRE, M.D.

## RADIUM

Biological Investigations Concerning the Effect of Graded Doses of Radium on the Skin. A. Reisner. *Strahlentherapie*, 1930, XXXVIII, 19.

The skin changes following exposure to radium were studied in a number of patients. It appeared that the application of doses considered as toleration doses in the literature produced severe reactions, sometimes a radio-dermatitis of the third degree. Tests proved that the over-dosage amounted to about 40 per cent. The doses were reduced accordingly and another series of skin exposures carried out showing that the reaction now corresponded to that of the erythema dose used in roentgen therapy. For the radium applicators used in the tests (14 platinum needles of 0.2 mm. wall thickness containing 3.3 mg. each, placed in a 1.2 mm. brass screen of 2 cm. length, total of 46.2 mg.), the skin tolerance dose amounted to 60 mg.-hrs. if placed directly on the skin and to about 310 to 330 mg.-hrs. if applied in one centimeter's distance from the skin.

The radium erythema was compared with the roentgen erythema. The principal differences were: the radium erythema was darker red and present over two months and longer; the maximum of the reaction appeared later, the pigmentation was more pronounced, and the depth effect greater. A comparison of the

effect of roentgen rays and radium rays can lead to reliable results only if based on identical skin reaction.

ERNST A. POHLE, M.D., Ph.D.

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**Efficacy of Radium Therapy in Advanced Cases of Cutaneous Carcinomata.** Felice Perussia. *La Radiologia Medica*, April, 1930, XVII, 397.

The author reports five cases of cutaneous carcinoma which were already unsuccessfully treated by surgery and radiation therapy. Favorable results obtained after a rational radium treatment convince him that the theory of radioresistance of tumor is not to be fully relied upon, and that an adequate radium technic yields surprising results even in cases of recurrent and advanced carcinoma of the skin.

L. MARINELLI.

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**Bacterial Flora in Uterine Carcinomata Treated with Radium.** A. M. Bonanno. *La Radiologia Medica*, July, 1930, XVII, 809.

A study of the bacteria present in 20 cases of uterine carcinoma reveals a heterogeneous flora, in which the staphylococcus and the *saccharomyces hominis* are predominant. Radium therapy seems to reduce the number and the virulence of the micro-organisms. The author shows that some germs disappear after treatment, while the hemolytic and proteolytic effects of others are augmented. It is believed that infected tumors react less favorably to radiation, and that local vaccinal treatment aimed to improve the bacterial flora should be resorted to in advanced cases of uterine carcinoma.

L. MARINELLI.

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**Biological Effects of Radium Irradiation.** R. G. Canti. *Acta Radiologica*, 1929, Vol. X, Fasc. 4, No. 56, p. 320.

In presenting a short review of the earlier observations on the histology of tumors which were irradiated with gamma rays of radium,

the author calls attention to the difficulties in the accurate interpretation of these observations, which were made in most cases on the patient. To overcome these difficulties, Strangeways and his co-workers, especially the author, studied the effect of radiation upon tissue cultures. The influence of time and of the intensity of the applied radiation upon the cell division rate was carefully observed. It was found that a certain threshold dose must be applied before any biological effect of the radiation can be observed. The selective action of gamma rays of radium upon cancer cells can be very well illustrated by the observation of cuttings from the famous "Canti film," a moving picture demonstrating the influence of radiation upon normal cells and Jensen's rat sarcoma cells. The selective action of beta rays on various bacteria is also demonstrated. The "stimulation effect" is discussed and an experiment made on tissue cultures is described, in which an increase in the cell division might erroneously be considered the result of stimulation.

OTTO GLASSER, Ph.D.

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**Experimental Investigation of the Action of Radium on Certain Micro-organisms.** Giuseppe Galli and Arrigo Foà. *Rivista di Radiologia e Fisica Medica*, August, 1930, II, 412.

The authors investigated the effect of radon on three common bacteria, namely, staphylococcus, streptococcus communis, and bacterium coli. The radon was in glass capillaries varying from 1 to 20 millicuries. Beta and gamma radiation from them both in liquid and solid cultures of these bacteria had little effect, and only when very high doses were used was there a slight retardation of growth. When the capillaries were broken in the culture and so liberated alpha, beta, and gamma radiation, they had a marked immediate bactericidal effect, and a less immediate effect on cultures more than twenty-four hours old. This effect is most marked in liquid cultures and transplants, and is directly proportional to the dose used and inversely

proportional to the volume of the culture and the number of bacteria. With solid media, the alpha rays have a limited bactericidal effect. The authors suspect that solid media are an almost insurmountable barrier to the diffusion of radon.

E. T. LEDDY, M.D.

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Radium Application Limited to the Fundus Uteri. Georg Kaboth. *Strahlentherapie*, 1930, XXXVII, 354.

Uterine bleeding can often be relieved by intra-uterine radium application limited to the fundus, which causes atrophy of the mucous membrane. The author attempted to choose the dose so that the bleeding would be regulated without causing sterilization. If from 1,000 to 1,500 mg.-hrs. were applied to a normal sized uterus, amenorrhea resulted. The same holds true of a slightly enlarged uterus in women near the climacteric. In cases with considerably enlarged uterus, this dose produced, however, the desired effect. It is deduced, therefore, that in women with a normal sized uterus at the ages between twenty and thirty, not more than from 400 to 800 mg.-hrs. should be given. This dose will affect the intra-uterine membrane but will not cause sterilization.

The technic of the procedure is described and accompanied by a sketch of the applicators used.

ERNST A. POHLE, M.D., Ph.D.

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Radium in the Treatment of Menorrhagia and Irregular Uterine Hemorrhage. Malcolm Donaldson. *British Med. Jour.*, Nov. 15, 1930, No. 3645, p. 813.

Only after exploration is it justifiable to say that the condition is due to an endocrine disturbance, such as is found at the time of the menopause. Having decided that the patient is suffering from an endocrine disturbance which is not benefited by drugs, the question of treatment will depend, first, on the age of the patient. If she is over 40, then there is no doubt but that the right treatment

is to create an artificial menopause by means of radiotherapy. The objection, of course, is the onset of menopausal symptoms, namely, flushing, sweating, headaches, etc.

There are two radiological methods by which the artificial menopause may be brought about: (a) radium, (b) X-rays.

The technic for using radium in the case of a patient who is over 40 is very simple. The patient is given an anesthetic, and after a careful bimanual examination the uterus is dilated and carefully curetted. If nothing abnormal is discovered, then a tube containing 50 mg. of radium element, the length of which is not more than 2 inches, is placed inside the cavity of the uterus. The walls of this tube must be the equivalent of at least 0.5 mm. of platinum, and in addition it is better to screen the metal filter with 2 mm. of rubber so as to cut off secondary rays. The length of time this tube should be left in position is still a matter of controversy. The majority of gynecologists consider twenty-four hours sufficient, but in a large uterus, with the ovaries near the pelvic wall, this sometimes fails to produce a permanent amenorrhea.

In X-ray treatment, a filter of 5 mm. of aluminum is used, 140 to 150 kilovolts (interrupted current), and a moderately full erythema dose is given to the skin. Two anterior ports of entry are used, and the applicator, applied with compression, is sloped, so that both ovaries get some of the rays. One or two posterior fields are employed, according to the stoutness of the patient—generally one. One of these fields is radiated on each of three or four successive days. This series of fields must be repeated on two further occasions, and it is most important that the beginning of the second series should be four weeks after the first, and the beginning of the third series four weeks after the second. This dose is slightly reduced for these subsequent treatments to compensate for the decreased tolerance of the skin. The method results in very little discomfort to most patients, and they can usually continue their ordinary avocations even during the treatment.

Another method, which is used for patients who live far away, is to sterilize in one treatment. This is a far more severe procedure

for most patients. A filter of 0.5 mm. of copper or zinc is used, 180 kilovolts continuous current, and two, three, or four fields at a 30 cm. distance. Less than an erythema dose is needed.

One advantage over radium is that X-rays can be satisfactorily used with quite large fibroids.

It has been clearly shown from results that: (1) the younger patients will stand a much larger dose without producing amenorrhea, and (2) this method of treatment must seriously be considered in certain cases, even if the patient is under 40, before resorting to hysterectomy.

The disadvantage is the fact that, owing to the position of the ovary being unknown, it is impossible to be certain of getting a dose that will be efficient and yet not produce permanent amenorrhea. The risk in young women of a permanent amenorrhea and severe menopausal symptoms perhaps makes subtotal hysterectomy preferable in the majority of cases.

WALLACE D. MACKENZIE, M.D.

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### RICKETS (DIAGNOSIS)

The Roentgen Diagnosis of Rickets.  
Ralph S. Bromer. *Am. Jour. Roentgenol.*  
and *Rad. Ther.*, May, 1930, XXIII, 469.

The limitations in the X-ray diagnosis of mild, early, or even more advanced cases of rickets must be recognized, since a certain number of cases will show a Harrison's groove, mild rosary, and lateral mobility of the knee joints, with entirely negative X-ray findings.

Two types, the passive and active, each of which show three stages, according to the degree of healing, are described by the author. The passive type shows no cupping of the diaphyseal ends at any stage, but does show early in the diaphyses of long bones: (1) diminution of lime content, (2) disappearance of zone of temporary calcification, with fine thin shadows running from the disappearing zone of temporary calcification into the resting cartilage of the epiphysis, while the epiphyses show increased width

and density of the proliferating and resting cartilage, moth-eaten outlines of the epiphyseal centers, the limiting border at times being absent with the entire nucleus appearing as only a faint haze. The early stage, active type, shows the changes seen in the passive type, but, in addition, the cupping at the diaphyseal ends is also present.

The second stage, passive type, shows: re-appearance of the zone of temporary calcification, which at first is faint but which later becomes wider and denser. Between this and the site of the old zone of temporary calcification is a layer of homogeneous bone of lesser calcium content representing the osteoid layer. The return to normal of the epiphyses is represented by, at first, a zone of temporary calcification encircling an osteoid layer of bone. Gradually the moth-eaten, hazy appearance of the epiphyseal centers is replaced by bone of normal structure.

In the second stage, active type, the osteoid layer appears as in the passive form, and, in addition, coarse striations appear in the spongiosa on the shaft-side of the osteoid layer, and at times small cystic areas are also noted. The epiphyseal centers, in addition to showing the changes of the passive type, seem to broaden to meet the widened diaphyseal ends.

In the third stage, both types show a dense, eburnated appearance of the cortex of the long bones, the zones of temporary calcification also being thick, broad and dense. Transverse striations across the diaphyseal ends are often found, although these are, of course, not pathognomonic of healed rickets, but merely represent any disease which at some time has arrested bone growth.

The writer has seen fragmentation of the lower inner border of the diaphysis of the femur and of its lower epiphysis, and of the upper epiphyseal center and upper and lower borders of the tibial diaphysis, with sufficient frequency in this series to suggest that it is an end-result of the rachitic process.

J. E. HABBE, M.D.



**Osteomalacia and Fetal Rickets.** J. Preston Maxwell. *British Jour. Radiol.*, August, 1930, III, No. 32, p. 375.

The author believes true osteomalacia to be a manifestation of rickets in adults whose bones have reached a stage of maturity, the disease then being due to deficiency of Vitamin D, with actual calcium starvation. Clinically, the patient is apt to complain of pain in the back and thighs, and, if advanced, may show marked deformity of the bones of the chest or pelvis, or of the long bones, there often being bending and crumpling of the weight-bearing bones, with a tendency toward pathologic fracture. In the well marked case, the generalized transparency of all of the bones, which also show a trabeculated appearance, together with certain rather characteristic deformities, make for a reasonably certain diagnosis, although hyperparathyroidism and pseudo-osteomalacia malignum may give the same general picture.

In the severer cases of osteomalacia in child-bearing women, the X-ray may demonstrate well marked rickets already present in the newborn.

Illustrations of cases of this nature before and subsequent to appropriate anti-rachitic therapy, are included with the article.

J. E. HABBE, M.D.

## ROENTGENOTHERAPY

**Spinal Roentgen-ray Therapy in Dermatitis Herpetiformis.** Harry R. Foerster. *Wisconsin Med. Jour.*, October, 1930, XXIX, 571.

Roentgen-ray therapy of the spine for cutaneous diseases probably had its inception in the treatment of herpes zoster, and later of lichen planus. The first investigators radiated the sensory nerve roots of the cord, giving rise to the term "radicular therapy." The technic of Driver is the one advocated for the condition described. Two fields are exposed; one interscapular, at the level of the second dorsal vertebra, and the other dorso-lumbar, at the level of the second lumbar vertebra. The rays are perpendicular to the spinous processes. 112 K.V., 5 ma., 25 cm. distance. 3 mm.

Al filter, and  $7\frac{1}{4}$  min. time. This is five-eighths of an erythema dose, repeated if necessary in six weeks. Two cases are reported in which the results were good.

W. W. WATKINS, M.D.

**On the Biologic Effect of Roentgen Rays. Fourth Communication: The Increase of the Roentgen-ray Effect by Secondary Radiation.** Ph. Ellinger and E. Gruhn. *Strahlentherapie*, 1930, XXXVIII, 58.

The effect of substances producing secondary radiation was studied on photographic emulsion and cultures of bacterium prodigiosum. Elements of the atomic numbers from 13 to 92 were used. The effect of the secondary radiation on the photographic plate increased with decreasing wave length of the primary radiation, and with increasing atomic number of the radiating substance. The relation is not linear but there are peaks in the curve. By using aluminum oil as a filter, it becomes probable that the secondary rays are identical with the fluorescent rays of the various series. In order to injure cultures of bacterium prodigiosum by primary roentgen rays, they must be given in doses exceeding 500 r. Between 1,000 and 3,000 r the bacteria are killed. A small percentage survives doses even over 5,000 r. If elements of high atomic number are used for the production of secondary radiation, doses of 300 r of the primary radiation suffice for a complete sterilization of the culture. Primary radiation is most effective if produced at about 100 K.V. The injurious effect of the secondary radiation increases with increasing wave length of the primary radiation, assuming equal doses of primary rays. The bactericidal effect of primary rays is somewhat dependent upon the intensity; lower intensities have a greater effect, assuming equal doses. This factor does not enter if secondary radiation is being used. The bactericidal effect of secondary radiation increases with increasing atomic number of the radiating element; there are characteristic maxima and minima depending upon the wave length of the primary radiation. The bactericidal rays have a very low penetration. An air

layer of from 4 to 5 mm. absorbs them completely. The penetration of the secondary bactericidal rays increases with decreasing wave length of the primary rays. The bactericidal effect is still present even if the radiating element is used in a dilution as low as 1 per cent.

The author concludes that the bactericidal effect of roentgen rays is mostly due to photo-electrons of first and second order.

ERNST A. POHLE, M.D., Ph.D.

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**The Treatment of Boils and Carbuncles by Roentgen Rays.** Eugene T. Leddy and S. Archibald Morton. Minnesota Med., August, 1930, XIII, 554.

Although the roentgen rays have been used successfully for more than twenty years in the treatment of boils and carbuncles, the value of the method is not appreciated by most physicians. The histories of 100 cases have been reviewed, comprising 74 cases of boils and 26 cases of carbuncles. For maximal value the X-ray treatment must be given early, and is considered successful if the lesion disappears in two days or less, and unsuccessful if the process is not materially shortened, even though pain may be relieved. Of the 74 cases of boils, there were only four failures, and of the 26 cases of carbuncles, there were six failures. For boils the technic was as follows. 135 K.V., 4 mm. aluminum filter, 16-inch distance, 5 ma., 10 minutes. For carbuncles the same factors were used for from 15 to 18 minutes. Care must be taken that the field is wide enough to include all the diseased area. If treated when induration alone is present, there should be 80 per cent of cures, without suppuration and without scarring.

W. W. WATKINS, M.D.

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**A Comparison of the Biological Effect of Roentgen Rays and Gamma Rays of Radium.** R. Braun. Strahlentherapie, 1930, XXXVIII, 11.

A comparison of the skin toleration dose of gamma rays of radium expressed in r-units, as measured by a number of investigators, shows a considerable discrepancy in the results.

Since the ionization method offers serious difficulties, the author used a biologic test in an attempt to solve the problem. The radium preparations had a length of 15 mm., were filtered through 1 mm. platinum, and were applied at 1 cm. distance from the center to the biologic object. The effect of graded doses of filtered roentgen rays (2,375 r to 6,500 r, half value layer in copper 1.76 mm.) on the eggs of *Ascaris* was compared with graded doses of radium. Based on the identical amount of injury to the *Ascaris* eggs, it appeared that 1 mg.-hr. at 1 cm. distance corresponded to 4.06 r. Tests carried out on that basis with human skin showed that 185 mg.-hr. at 1 cm. distance produced a definite erythema corresponding to that produced by 750 r of filtered roentgen rays. This value is much lower than the majority of previous investigators have offered. The variance is partly explained by the influence of the time factor. Much higher total doses are tolerated by the skin without excessive reaction if given by the fractional method over a long period.

ERNST A. POHLE, M.D., Ph.D.

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**The Blood Sugar Regulation under the Influence of Roentgen Rays.** A. Held. Strahlentherapie, 1930, XXXVIII, 27.

The fluctuations of the blood sugar following exposure to roentgen rays were studied in rats and dogs. The author concludes that one must differentiate between the systemic effect of the blood sugar regulation and the direct effect of the sugar transformation in the irradiated area itself. The general effect of the irradiation manifesting itself in a hyperglycemia is due to cell decay products found in the blood following the exposure. This was proved by re-injection of irradiated blood, which also produced hyperglycemia. The principal factors are apparently an increased hydrogen ion concentration, the transmineralization, and the splitting of proteins. The direct effect of the irradiation on the blood sugar was studied by determining the sugar in the blood of an exposed and an unexposed posterior extremity. In the irradiated tissue there

was a relative hypoglycemia. It is shown that the muscle cell itself may take an active part in the sugar regulation.

ERNST A. POHLE, M.D., Ph.D.

**Irradiation of the Sympathetic Ganglia: A Valuable Therapeutic Procedure.** K. H. Beall and S. Jagoda. *Texas St. Jour. Med.*, August, 1930, XXVI, 279.

The authors have demonstrated that they can cause a more or less permanent increase in the blood supply to an extremity by radiating the proper sympathetic ganglia. This report is limited to its use in cases in which the arms and legs were affected, though the authors are working to effect an increase in the blood supply to the heart, kidney, and other viscera. Seven cases of thrombo-angiitis obliterans (Buerger's disease) have been treated, in six of which the symptoms were completely relieved. Two cases of Raynaud's disease were treated, with complete relief in two. Three cases of painful claudication from arteriosclerosis were relieved. Some encouraging work has been done in arthritis. The technic was as follows: Weekly treatments at 200 K.V., 4 ma., 25-inch distance,  $\frac{3}{4}$  mm. copper and 1 mm. aluminum for from 10 to 15 minutes.

W. W. WATKINS, M.D.

**Experience with the Combination Isamin Blue Radiation Treatment.** H. Cramer. *Strahlentherapie*, 1930, XXXVIII, 123.

The author combined isamin blue injections with radiation therapy in far advanced cases of malignant tumors. The technic of Roosen-Bernhardt was used: 0.4 gram isamin blue was dissolved in 50 c.c. of a 0.5 per cent sterile glucose solution; this must not be heated above 80 degrees or kept longer than 48 hours; 2 c.c. of glycerin are taken up in a syringe, then 10 c.c. of the isamin blue solution, and then a few drops of physiological sodium chloride solution. This is well mixed; three-fourths c.c. of a physiological sodium chloride solution is injected first, followed by a slow injection of the mixture. A series usually consists of from ten to twelve injections; two

of 5 c.c. each, two of 10 c.c. each, and from six to eight of 15 c.c. each. In this way, the patient receives a total of from 1 to 1.2 gram of isamin blue. This scheme sometimes must be adapted to the individual needs. The beneficial effect of the combined treatment is demonstrated in a case of bronchial carcinoma which is very difficult to influence.

In conclusion, the author emphasizes that the isamin blue injections should be considered only as an adjunct to radiation therapy.

ERNST A. POHLE, M.D., Ph.D.

**The Specific Radiosensitiveness of Lymphocytes: Its Significance in Radiotherapy.** Arthur U. Desjardins. *California and Western Med.*, November, 1930, XXXIII, 775.

The author states as follows: "The specific radiosensitiveness of different varieties of cells has been so thoroughly tested and proved by innumerable experiments on animals that it deserves to be recognized as a law. . . . I should like to submit the case of the lymphocyte, which, of all the cells in the body, is by far the most sensitive to irradiation. The fact itself is well known, but its therapeutic implications are not commonly realized. Nowhere in the field of radiotherapy can a more instructive example of the specific sensitiveness of cells be found."

The author reviews Heineke's work of irradiation experiments with animals, with particular reference to the lymphocytic reaction. The lymphocytes are destroyed and the nuclear chromatin is then taken up by the remaining intact cells. The phagocytic disposal of the degenerate nuclear chromatin continues until the lymphocytes in the follicles are largely destroyed, but a small percentage of these cells appears to resist the action of the rays. He also reviews the work of many authors, which confirms the work of Heineke. How may these facts be applied to clinical radiotherapy, and how closely does clinical radiotherapy correspond to the experimental data? It has long been known that many acute and chronic, suppurative or non-suppurative, inflammatory conditions are easily amenable to irradiation, and in some of these conditions roentgen-ray or radium treatment

has been found to be the therapeutic method of choice. As examples, he mentions furuncle, carbuncle, delayed resolution in pneumonia, trachoma, erysipelas, and parotitis. He then discusses the various reactions seen in irradiation of various pathologic conditions.

The mode of action of irradiation is not due to the direct action on infecting organisms, because all experiments testing the bactericidal influence of irradiation have almost constantly been negative. The experiments on animals have shown that the leukocytes and lymphocytic tissue in the irradiated territory may be caused to disintegrate. The chief points to bear in mind are that the destructive action of the rays begins soon after exposure, although visible effects may not become perceptible for several days, and that a considerable degree of lymphocytic disintegration occurs even after a small dose of irradiation.

When an inflammatory lesion is irradiated, destruction of the infiltrating lymphocytes is to be expected. But, since leukocytic infiltration is such an important factor in the defense against infection, the question naturally arises as to why the destruction of a large number of the lymphocytes infiltrating such lesions may not do more harm than good. The only answer is that no one has yet submitted any evidence of such ill-effect. Always the influence of irradiation has been favorable or the rays have failed to alter the course of the inflammatory process. When the author first attempted to ascertain the therapeutic value of irradiation for lesions of this character, this question was uppermost in his mind, and he carefully analyzed all the known experimental and clinical facts.

In the words of the author: "How may such an apparent paradox be explained? After trying to correlate the experimental and clinical observations, I have formulated the following hypothesis which appears to harmonize with all the known facts. If it can be assumed that the leukocytes, and especially the lymphocytes, which the organism mobilizes around the site of infection represent an effort to localize the infection and to get rid of the infectious material by phagocytosis or otherwise, it must also be assumed that the infiltrating cells contain or elaborate within them-

selves the protective substances or other means which enable them to destroy or neutralize the bacterial or other toxic products which give rise to the defensive inflammation. If these assumptions are well founded, it seems not unreasonable to deduce that irradiation, by destroying the infiltrating lymphocytes, causes the protective substances contained by such cells to be liberated and to be made even more readily available for defensive purposes than they were in the intact cells. There can be little question that the rays act by destroying the infiltrating leukocytes, and that the value of radiotherapy depends chiefly on such action."

The therapy of tumors of the lymphoid tissue is also discussed.

F. B. SHELDON, M.D.

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**The Sensitizing Effect of Hematoporphyrins to Roentgen Rays.** N. A. Podkaminsky. *Strahlentherapie*, 1930, XXXVIII, 98.

Hematoporphyrin was injected into white mice which were exposed to roentgen rays in the dark. The same sub-acute and chronic types of the disease which usually develops after light exposure of sensitized animals were observed in these mice. It is concluded, therefore, that hematoporphyrin is a sensitizing agent for roentgen rays as well as for light rays.

ERNST A. POHLE, M.D., Ph.D.

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**Principles of the "Long Weak" Treatment Method.** G. Schwarz. *Strahlentherapie*, 1930, XXXVII, 709.

The author explains a treatment method which permits the use of roentgen rays similar to radium. Very low tube currents (0.5 ma.) are employed for prolonged periods. In order to facilitate the practical work, special transportable X-ray apparatus is being constructed according to the author's design which can be moved to the sickroom and connected to the ordinary light circuit. The chief advantage of the method lies in the production of very mild skin reaction even though very high total

doses may be applied (2.5 r per minute, 1,800 r during 36 hours) with several hours' interval between the treatments.

ERNST A. POHLE, M.D., Ph.D.

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**Roentgenotherapy of Bronchial Asthma.**  
G. M. Sack. *Röntgenpraxis*, Oct. 1, 1930, II, 890.

Before roentgenotherapy for asthma is instituted the diagnosis must be certain. In this way one avoids giving unnecessary treatment for tuberculosis or heart and blood-vessel diseases. The number of eosinophiles in the blood picture does not give any indication for the prognosis, as far as irradiation is concerned. Old cases also react well to roentgen treatment. Secondary changes, however, caused by the long existence of asthma, cannot be influenced. Irradiation of the lung hili through four small fields ( $6 \times 8$  cm.), with 0.5 Zn filter and  $1/10$  to  $1/5$  of a skin erythema dose, gives good and lasting results and is less troublesome to the patient than larger doses.

Of 45 patients treated by the author, 25 were cured, 6 considerably improved, 4 did not react, and 10 could not be followed up. Children especially reacted very well. Patients treated in an early stage may be benefited sooner and easier than old cases. The action of the rays may be explained by changes in the tonus of the sympathetic and parasympathetic system. These changes are probably of biochemical nature. Other allergic diseases react to irradiation as does asthma.

H. W. HEFKE, M.D.

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**Xanthomatosis (Schüller's Disease; Christian's Syndrome): A Report of Three Cases Treated with Roentgen Rays.** Merrill C. Sosman. *Am. Jour. Roentgenol. and Rad. Ther.*, June, 1930, XXIII, 581.

Three cases of probable xanthomatosis are reported, two occurring in children aged two and a half and four and a half, and the third in a man aged fifty-five. All three showed general improvement under X-ray treatment, and corresponding improvement in the defects

in the membranous bones. The characteristic roentgen findings are irregularly rounded areas of destruction in the skull and pelvis, with occasional lesions in other bones. Diabetes insipidus and exophthalmos are frequently associated findings, and these indicate the presence of xanthoma tumors in the region of pituitary body and orbit. While the etiology of the disease is unknown, a definitely disordered fat metabolism is constantly present, which accounts for the previously reported good results with low fat diets, although two of the three cases reported herein showed no response with such dietetic regulation. The important finding of the author is the consistently good response in each case to irradiation therapy.

J. E. HABBE, M.D.

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**Value of Roentgenotherapy in Carcinomatous Metastasis of Bone.** Arduino Ratti. *Rivista di Radiologia e Fisica Medica*, August, 1930, II, 389.

This is a report of a patient with extensive metastasis to the bones of the pelvis following carcinoma of the breast, who was clinically well a year after treatment.

E. T. LEDDY, M.D.

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**Further Experience with the Roentgen Treatment of Brain Tumor.** Karlheinz Backmund. *Strahlentherapie*, 1930, XXXVII, 59.

Since the last report from the author's clinic (*Strahlentherapie*, 1928, XXIX, 678) of forty-two cases of brain tumor, thirty-two additional patients were seen in 1927-28. Twenty-five of these cases could be used for the statistics. Eight patients were clinically cured, three were permanently improved, four temporarily improved, nine not improved, while one died immediately after the first irradiation. In spite of this fatality, the author can not agree with the statement made in the literature that in each case of brain tumor, a decompression should be carried out before starting X-ray deep therapy. He urges that X-ray therapy be given a trial in each case of

brain tumor, and, if this treatment fails, all well localized tumors should be removed by surgery.

ERNST A. POHLE, M.D., Ph.D.

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**Radiation Therapy in Menstrual Headaches.** Charles L. Martin. *Texas St. Jour. Med.*, August, 1930, XXVI, 280.

One type of menstrual headache appears to be due to some improper relationship between the secretions of the pituitary and the ovary. It is usually absent during pregnancy and relieved by the menopause. An artificial menopause produced during the latter years of the menstrual life brings about a cure or marked relief in many such cases. The artificial menopause should never be induced in young women except under unusual circumstances. Mild glandular radiation when properly understood, and when not carried too far, may prove of value.

W. W. WATKINS, M.D.

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**Present Methods and Results of Radiation Therapy in Carcinoma with Fractional Doses.** Leopold Freund. *Strahlentherapie*, 1930, XXXVII, 795.

The author acknowledges the fact that the fractional dose method in the treatment of carcinoma is more and more practised to-day and with very good results. Since he recommended this method twenty-five years ago, he claims priority for the idea of increasing the effect of radiation on tumor tissue by subdividing the dose.

ERNST A. POHLE, M.D., Ph.D.

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**Testicular Seminomas and Their Treatment by Means of Roentgen Rays.** J. B. Porchovnik and G. N. Treister. *Röntgenpraxis*, Oct. 15, 1930, II, 927.

The seminomas are the most common tumors of the testis. Sixteen such cases have been treated by the authors during the last four years. As metastases often take place soon after surgical removal, it seems advisable to treat the field of operation and the

surrounding lymph glands soon afterwards. The seminoma itself, as well as its metastases, is very sensitive to roentgen rays. One should begin the treatment with one-fourth skin erythema dose per field, and should give larger doses later only in refractory tumors. Roentgen therapy is the only method of treatment in neglected cases and metastatic tumors of different organs. One may even succeed in achieving a complete cure in some cases, and often in improving the condition of the patient considerably for many months and even years.

H. W. HERKE, M.D.

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**Auxiliary Methods in Radiation Therapy of Carcinoma.** Henri Hirsch. *Strahlentherapie*, 1930, XXXVII, 767.

A number of measures have been described which serve as adjuncts to radiation therapy in malignant disease. The author discusses briefly the copper iontophoresis of the uterus as practised by Wintz, the gas treatment by Fischer-Wasels, the dye injection of Roosen, and the bismuth injections of Kahn and Wirth. The lead therapy of Blair Bell is also mentioned. Hirsch himself has seen favorable results from the injections of Dextrozid, which is an iodine-cer compound coupled to hypertonic dextro solution. Diathermy and organ extracts may also prove valuable in combination with radiation therapy.

ERNST A. POHLE, M.D., Ph.D.

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**Plantar Warts.** Cyril K. Valade. *Jour. Michigan St. Med. Soc.*, July, 1930, XXIX, 521.

The treatment of plantar warts numbers three methods: plasters or pastes containing keratolytic drugs, surgical diathermy, and radiation. X-ray therapy is perfectly safe in the hands of a competent radiologist. The procedure is simple. The surrounding skin is screened to the edge of the lesion, then unfiltered radiation is applied for the required dosage. MacKee advises one and one-half skin units; this will depend on the amount of cal-

losity present, so that two or more skin units may be required. If the wart has not disappeared in four weeks, it is safe to give another dose.

W. W. WATKINS, M.D.

**A Case of Endometriosis Rectovaginalis Treated Successfully by Roentgen Rays.** James Heyman. *Strahlentherapie*, 1930, XXXVII, 590.

The history of a woman thirty-one years of age suffering from an extensive endometrioma is related by the author. Since operation did not bring relief, she was referred for radiation treatment. She responded well to roentgen therapy, and, following a period of amenorrhea, menstruation returned. Heyman suggests, therefore, the revision of the textbook opinion which assumes that roentgen therapy is not indicated in the treatment of endometrioma.

ERNST A. POHLE, M.D., Ph.D.

**The Effect of X-rays on the Reticulo-endothelial System of the Spleen.** Ettore Conte. *Rivista di Radiologia e Fisica Medica*, August, 1930, II, 430.

The author reports experiments on the action of X-rays in producing the so-called "block" of the reticulo-endothelial system of the spleen. He found a paralyzing effect on the activity of the cells to take up colored substances and suspensions of granules of India ink. This effect began a few hours after irradiation, and was of short duration.

E. T. LEDDY, M.D.

**The Roentgen Therapy of Subacute and Chronic Pelvic Inflammatory Diseases.** L. Seitz. *Strahlentherapie*, 1930, XXXVII, 595.

The author has observed in his clinic, 380 cases of pelvic inflammatory disease, 366 of which were treated by roentgen rays. About 78 per cent were improved, subjectively as well as objectively. *Technic*: 180 K.V., 1.0 mm. Cu + 1.0 mm. Al, one abdominal field 20 cm.  $\times$  20 cm., 15 per cent to 20 per cent

E.D. on the surface or 4 per cent to 6 per cent E.D. in the depth. In addition to that, hot douches, diathermy, and other conservative methods of treatment were used.

An analysis of these cases leads to the following conclusions: In acute cases of gonorrheal etiology, roentgen rays should not as a rule be used; no contra-indications exist for the acute types of parametritis. The principal domains for roentgen therapy in small doses are the subacute and chronic diseases of the adnexa, and also parametritis. Even in cases of gonorrheal infection of the tubes, roentgen therapy is beneficial in 75 per cent of the cases, and certainly must be recommended as a valuable adjunct of other therapeutic measures. The inflammatory processes in the peritoneum are favorably influenced in almost 100 per cent of the cases. In order to judge the therapeutic effect, it is suggested that one observe the leukocyte count and also the blood sedimentation. Particularly in septic types of pelvic inflammatory disease, these tests give valuable information as to the efficacy of the therapeutic measures.

ERNST A. POHLE, M.D., Ph.D.

**Roentgen Treatment of Lymphogranulomatosis.** H. U. Billich. *Strahlentherapie*, 1930, XXXVIII, 141.

The author observed thirty-one cases of Hodgkin's disease, 38.7 per cent of the patients being women, most of them young or of middle age—twenty-three were between the ages of ten and forty. A table gives the localization, stage of the disease, the time of observation, and the results of the treatment. It appears that 25.5 per cent lived two years and longer; 29 per cent lived three years, and two patients lived over three and five years, respectively. One woman has been under treatment since 1920, had a recurrence in 1927, and is still alive. The author emphasizes that roentgen therapy should be administered in medium doses. As a matter of fact, a study of the literature shows a definite tendency towards a reduction of the amount of irradiation prescribed in Hodgkin's disease. Particularly the soft glands require only small

doses. From 50 to 200 r (170 K.V. to 180 K.V., 0.5 Zn + 1.0 Al) are usually given in the author's clinic. High doses lead to a rapid destruction of the pathological tissue, the absorption of which by the blood stream causes violent systemic reactions. The application of the lowest possible dose necessary to bring about relief is, therefore, the method of choice. In addition to irradiation, the general treatment of the patient must not be neglected.

ERNST A. POHLE, M.D., Ph.D.

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**Roentgen Therapy of Agranulocytosis.** F. Burghelm. *Strahlentherapie*, 1930, XXXVIII, 152.

The application of very small doses of highly filtered roentgen rays (30 r per field, 175 K.V., 0.6 mm. Cu) over as many bone-marrow areas as possible in the beginning of the disease, is recommended by the author. In his experience, this treatment helped in restoring the regenerative function of the bone marrow.

ERNST A. POHLE, M.D., Ph.D.

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**Further Experience with Roentgen Therapy in Tuberculosis of the Adnexa.** H. Eymmer. *Strahlentherapie*, 1930, XXXVII, 603.

The author reports briefly the results obtained by roentgen therapy in fourteen women suffering from tuberculosis of the adnexa. The patients were between fifteen and forty-four years old; only one had had one miscarriage and seven had carried a pregnancy to full term. They received very small doses of roentgen rays two to six times, at intervals of from a few days to a few weeks. One large field over the abdomen was given. Twelve of the fourteen patients were considerably improved, one remained unchanged, and one died from intestinal tuberculosis.

Although we do not know the mechanism of the effect of roentgen rays on tuberculous tissue, it seems apparent that small doses of roentgen rays are of benefit in these cases. Before attempting X-ray therapy, active tuberculous processes in lungs, intestines, or genitourinary tract must be excluded.

ERNST A. POHLE, M.D., Ph.D.

**Unusual Deposition of Calcium in Connective Tissue.** Max Cohn and Freye. *Med. Klinik*, Sept. 19, 1930, XXVI, No. 38, p. 1400.

An unusual case of generalized calcinosis is described, and several roentgen films are shown revealing the extent of the disease. The motility of the extremities was very limited on account of the extensive deposits of calcium around the shoulder. A trial of roentgenotherapy (1/5 of the erythema dose every second day until a full erythema dose was given) led to encouraging results. After the first week the patient complained less and had better use of his arms. It may be that the X-rays cause an increased amount of acid in the tissues, which again may lead to a dissolution of the calcium salts.

H. W. HEFKE, M.D.

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**Uterine Sarcoma and Roentgen Therapy.** Antoine B  cl  re. *Strahlentherapie*, 1930, XXXVIII, 113.

Radiation therapy can be used to advantage following the surgical removal of a sarcomatous uterus. It is indicated as the method of treatment in all inoperable cases, in all cases in which operation can not be performed, in all cases of recurrence, and for metastasis. The article has been published in French in *Gyn  c. et Obst  tr.*, January, 1930.

ERNST A. POHLE, M.D., Ph.D.

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**Actinomycosis (Mycetoma): Report of Six Cases in Georgia.** Jack W. Jones and Herbert S. Alden. *Southern Med. Jour.*, October, 1930, XXIII, 906.

By the term "actinomycosis" the authors mean a slowly progressive, chronic, infectious granuloma, caused by various fungi of different genera and species, presenting clinically nodular hypertrophies of the infected tissue, and frequently draining sinuses. The terms "actinomycosis" and "mycetoma," as used by Castellani, are synonymous. The manner in which the fungus enters the system is not definitely known. After gaining entrance to the tissues, the fungus grows slowly, but persist-



ently, extending mycelial filaments into the surrounding tissue. The connective tissue response is marked and much new tissue is formed far from the invading organism. The disease actinomycosis probably occurs more commonly than is believed. Six cases are reported by the author. The diagnostic fetish of "sulphur granules" is a mistake, and the appearance of such bodies marks a terminal condition. Except in one instance, no granules were ever found in the cases reported. The fungus may be demonstrated in the infected tissue by curetting the sinus. The treatment consists of the persistent use of iodine, arsenic, and by X-radiation. In the cases cited, the radiation applied was unfiltered and from one-fourth to one-half skin-unit dose a week.

(*Abstractor's note:* It would appear that the radiation used was inadequate, and that more intensive radiation, with moderately high voltage and moderate filtration, would have given better results.)

W. W. WATKINS, M.D.

**On Radiation Therapy of Pleuritis Carcinomatosa and Sarcomatosa Exudativa. I.** Heeren. *Strahlentherapie*, 1930, XXXVII, 735.

The histories of seven patients observed in Holfelder's Clinic, suffering from pleura metastases, are briefly related. In five cases, the primary tumor was in the breast, in one case in the uterus, and in another case there was a round-cell sarcoma in the head of the left humerus. While X-ray deep therapy of the metastatic malignancies in the chest did not lead to a cure, there was considerable improvement in the condition of the patients. A number of roentgenograms accompany the article, illustrating the effect of irradiation.

ERNST A. POHLE, M.D., Ph.D.

**A Contribution to the Roentgen Treatment of Para-urethral Infiltrates.** Sepp Grauer. *Wien. klin. Wchnschr.*, Aug. 14, 1930, XLIII, No. 33, p. 1032.

The good results of roentgenotherapy in complications of gonorrhea are well known,

especially in gonorrheal arthritis. Also an epididymitis, prostatitis, and vesiculitis can be favorably influenced by roentgen irradiation. Several cases of gonorrheal para-urethral infiltrates were treated by the author, with excellent results. The factors of dosage used were: 4 H, wave length  $\lambda_{\text{effective}} = 0.1 \text{ \AA.U.}$ , filtration 0.3 mm. Cu and 2 mm. Al. This dose was given three times at weekly intervals. The testicles were well protected by lead. Every case of this kind should be treated by roentgen rays before surgery is resorted to, and in most cases, the author believes, irradiation treatment will be so successful that surgery will not need to be employed.

H. W. HEFKE, M.D.

**Radiation Treatment in Myelogenous Leukemia.** Sigfrid Hammerschlag and Heinz Knospe. *Strahlentherapie*, 1930, XXXVII, 693.

There is related briefly the history of a woman who was suffering from myelogenous leukemia, with an enormously enlarged spleen which had previously been diagnosed as an ovarian tumor. She responded well to X-ray treatment (deep therapy technic) in small and moderate doses. The authors emphasize the statement that most radiologists believe in using this procedure rather than giving massive doses. One-third to one-half E.D. over the spleen or over the long bones is suggested.

ERNST A. POHLE, M.D., Ph.D.

**Principles of Roentgenotherapy: VIII.—Roentgen Therapy in Gynecology.** Ernst A. Pohle. *Wisconsin Med. Jour.*, August, 1930, XXIX, 442.

Paper No. 8 of this series discusses the use of roentgen therapy in uterine fibroids, in cases in which roentgen sterilization is desired, in amenorrhea, and in malignant conditions. For suitable cases of fibroids, X-ray therapy (or radium) is given preference by the majority of clinicians, and if strict indications are observed, the results approximate 100 per cent. When fibroids are large or pressure symptoms distressing, if the growth is sub-

mucous, subserous, or pedunculated, if the hemoglobin is below 40, if there are inflammatory processes in the adnexa, if the fibroid is necrotic, if the patient is in the child-bearing period, or if there is a suspicion of an ovarian cyst, surgery is usually preferred. Treatment is directed toward cessation of the ovarian function, and usually 35 per cent of the so-called erythema dose, or 250 r of heavily filtered radiation, is sufficient. A variety of technics are employed. The treatment of excessive menstruation in women close to the menopause is essentially the same. The matter of "temporary sterilization" in younger women is discussed and caution advised. The treatment of amenorrhea by small doses of X-ray has been advocated by some authorities. In malignancy of the uterus both radium and X-rays are used, since the radiation by radium alone cannot reach the pelvic glands. Roentgen rays of short wave length and in toleration doses are required. A thorough knowledge of the fundamentals of radiation therapy and continued study of reactions are the basis of good results. The possession of radium and an X-ray machine does not qualify any one to treat such cases.

W. W. WATKINS, M.D.

**Principles of Roentgenotherapy. IX.—Roentgen Therapy in Dermatology.** Ernst A. Pohle. *Wisconsin Med. Jour.*, September, 1930, XXIX, 507.

The first therapeutic use of X-rays was in skin diseases. The successful X-ray treatment of such lesions requires a careful study of the individual patient and continued observation after exposure. The author uses the outline of MacKee, and indicates the dosage and technic for treatment of the following conditions: diseases due to pyogenic organisms, diseases due to fungi, eczema, psoriasis, lichen planus, pruritus, diseases of the appendages, diseases of the hematopoietic system, tuberculous lesions, verrucous lesions, non-malignant neoplasms, and malignant neoplasms.

(Abstractor's note:—This article, like MacKee's writings, is very conservative, and many

radiologists would add a number of skin diseases to this list.)

W. W. WATKINS, M.D.

**Principles of Roentgenotherapy. X.—Roentgen Therapy in Pediatrics, Ophthalmology, Otology, Rhinology, Laryngology, Neurology, and Psychiatry.** Ernst A. Pohle. *Wisconsin Med. Jour.*, October, 1930, XXIX, 565.

In pediatrics a number of conditions are amenable to radiation therapy; many peculiarities connected with a growing organism demand special consideration in establishing indications and contra-indications, as well as in establishing technic. In enlarged thymus, the majority of radiologists use X-rays, some preferring radium. Small doses of X-rays are used, 30 r to 75 r, with potentials from 100 to 130 K.V., 4 mm. Al or 0.25 mm. copper. Tuberculous glands may be successfully treated, the single dose of moderate penetration of from 50 r to 150 r, repeated two or three times at intervals of from three to ten days. From four to six weeks should elapse between such series. In acute leukemia, radiation is not used. In chronic leukemia, the same method of application as in adults is used; the same is true in Hodgkin's disease. In the treatment of inflammatory conditions, the principal point is the use of small doses, 30 r to 75 r, the penetration being of minor importance.

In the eye the number of conditions amenable to radiation is limited, although considerable literature has accumulated on the radiation treatment of malignancies in and around the eye. In the ear, radiation is usually used in inflammatory conditions. Sinusitis, with severe pain, is often relieved by X-ray. Hypertrophied tonsils sometimes reduce under X-ray treatment, fairly high doses of filtered rays being advised. Perhaps the treatment is more applicable to the hypertrophied lymphoid tissue of the pharynx. In brain tumors, radiation therapy should be given a trial, and it is safe to apply 200 r per field for four days, or until the tumor itself has received about 600 r.

Tumors of the hypophysis may be given 200 r to 300 r of heavily filtered radiation through each of three portals, repeated after two to

four weeks. Cases of syringomyelia, poliomyelitis, encephalitis, multiple sclerosis, and tabes have also been radiated.

W. W. WATKINS, M.D.

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**Nitrogen Excretion in the Urine Following Roentgen and Radium Treatment.** Günter K. F. Schultze. *Strahlentherapie*, 1930, XXXVII, 642.

Forty-two patients were placed on a certain diet until the nitrogen excretion became constant. Twenty-two were treated by roentgen rays over the pelvis, eight received radium, and the twelve remaining patients were treated for non-malignant conditions and served as controls. It appeared that following radium treatment, the nitrogen in the urine was increased in all cases. This increase is more constant and higher than following roentgen treatment. While other investigators found that the creatinin nitrogen was also increased, the author could not confirm their observations. The conclusion is reached that the determination of the nitrogen in the urine following irradiation cannot be used as a factor in prognosis or biologic dosimetry. Further studies are necessary in order to give a broader basis for this problem.

ERNST A. POHLE, M.D., Ph.D.

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### SKIN (THERAPY)

**Ringworm of the Hands and Feet.** Wilmoth A. Osborne. *Med. Sentinel*, August, 1930, XXXVIII, 426.

Ringworm of the hands and feet may be caused by any one of several kinds of fungi. The clinical appearance and symptomatology show great variability, with some definite and constant features. Usually the primary lesion is a deep-seated vesicle along the sides of fingers or toes; the lesions may be discrete or may coalesce. The changes may run the gamut from acute erythema, through vesicular and pustular, into scaly and indurative forms.

In the discussion of treatment this author says: "The roentgen ray has been lauded by a number of observers. In some of the acute

eczematoid cases it gives improvement, but again it is only one of the many measures which may be tried. There is little rational therapeutic basis for its use in any other form than the acute eczematoid type."

(*Abstractor's note*:—Radiologists who have had experience in treating eczematoid ringworm will hardly agree with this brief dismissal of the use of the X-ray in the condition. It is true that the X-ray is usually tried "when all else fails"; it is also just as true that it usually relieves the condition when it is tried.)

W. W. WATKINS, M.D.

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**Studies of the Changes of the Skin Tolerance Using the Fractional Dose Method with Varying Intervals.** Alfred Reisner. *Strahlentherapie*, 1930, XXXVII, 779.

The skin reactions produced by a number of modifications of the saturation method were studied on the skin of the thigh. A 2 cm. X 2 cm. field exposed to 1,000 r in one sitting served as control. The skin reactions were determined with the tintometer designed by Schall. A color plate showing the exposed areas on the fortieth and fiftieth days, respectively, following exposure illustrates the results. The reactions are carefully analyzed in a number of graphs. If a lower initial dose than 1,000 r was given, higher doses had to be applied than indicated by the saturation curve of Pfahler in order to get the same degree of erythema as in the case of a full initial dose. It also appeared that saturation at daily intervals produced less reaction than if carried out at two-day intervals.

ERNST A. POHLE, M.D., Ph.D.

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**Skin Diseases about the Eyes.** Russell Fields. *Virginia Med. Monthly*, July, 1930, LVII, 248.

Chronic eczema is frequently benefited by mild doses of X-ray. In external angular conjunctivitis, cauterization with silver nitrate, together with small doses of X-ray, will be found useful. In epitheliomas upon and sur-

rounding the eyelids, the judicious use of X-ray and radium, with desiccation when indicated, will cure the average case. The eye is less susceptible to radiation than the surrounding structures.

Other conditions are discussed in which radiation is not advised as treatment.

W. W. WATKINS, M.D.

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**The Influence of Air Pressure on the Formation of Erythema and Pigmentation in the Skin.** F. Schmidt-Labaume and E. Uhlmann. *Strahlentherapie*, 1930, XXXVIII, 54.

A number of skin areas were exposed on the backs of patients, to a Kromayer lamp. By means of a special arrangement, it was possible to apply the radiation under a positive or negative air pressure of 40 mm. mercury. The increased pressure led to a decrease in the erythema and pigmentation, while the negative pressure increased these reactions. These results are explained by the anemia or hyperemia of the exposed skin.

ERNST A. POHLE, M.D., Ph.D.

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**Dermatologic Therapeutics: Basic Principles and Technic.** Moses Scholtz. *California and Western Med.*, November, 1930, XXXIII, 769.

The author discusses the therapeutics of dermatology, with special reference to the general practitioner. The types of skin found in different individuals and different locations, and some of the principles of diagnosis are discussed. He says that failure to correctly recognize the primary and secondary lesions and interpret their proper relationship is responsible for many therapeutic failures. As a rule, the secondary lesion should be treated first. He spends quite a bit of time in discussing details in the proper application of therapeutic remedies, and also gives attention to diet, general regimen, and internal medication.

The most effective and powerful of all therapeutic resources available to dermatologists is physiotherapy. Ultra-violet light,

quartz lamp, or carbon arc possesses dermatologically the following effects: (1) bactericidal; (2) antipruritic; (3) stimulative regenerative; (4) superficially destructive peeling. On the other hand, X-ray and radium in small and medium doses exert a stimulative, alternative, and deep absorptive effect, and large doses are lethal to rapidly growing tissues. Hence ultra-violet light is indicated in all superficial itching, infectious, bacterial or mycotic, local or systemic dermatoses. The X-ray should be used only in deeper, infiltrating, inflammatory dermatoses, infectious granulomas, bacterial or mycotic, and in skin malignancy.

For a clinician who uses the X-ray in skin cases, a thorough grounding in diagnostic and therapeutic dermatologic technic is an important qualification. A principle that should be indelibly impressed upon the mind of a clinician using the X-ray in skin diseases is that the therapeutic skill of a clinician is measured by the smallest dosage used in obtaining desirable therapeutic effect.

Over-treatment, so often observed in the X-ray treatment of skin disease, refers not only to the quantity of ray expressed in amperage, but also to the quality of ray as well, a much higher voltage being commonly used than is necessary for therapeutic effect or compatible with safety to the skin.

Similarly, in the field of the ultra-violet light there is a tendency to use erythema and blistering doses more often than is necessary. Commercial circulars flooding the profession have hypnotized the average practitioner into a belief that nothing short of an erythema or blistering dose is sufficient for therapeutic results. In actuality, most of the major therapeutic effects obtained through ultra-violet light rays, such as antipruritic, bactericidal, and stimulating regenerative, are obtained by small fractional or medium doses, away below the erythema stage. The superficially destructive and peeling effect of the erythema dose is desired only in a very small minority of dermatoses, such as chronic circumscribed dry scaly mycotic dermatoses, acne, psoriasis, alopecia areata, and some other selected cases.

F. B. SHELDON, M.D.

The Possibility of Preventing Radiation Injuries to the Skin. Erich Uhlmann. *Strahlentherapie*, 1930, XXXVIII, 103.

Raderma cream, which consists of adeps lanæ, vaseline, ceresin, and oily or watery extracts from semen terminaliæ, folia psidi pyri-feri, and radix rumicis crispis has been recommended by Wintz as prophylaxis for severe skin reactions following exposure to roentgen rays or radium. The author investigated the value of this ointment, and found that the application of the preparation reduced the effect of the exposure on the skin by approximately 20 per cent. He recommends its use, therefore, particularly in cases in which more than one series of treatments must be given.

ERNST A. POHLE, M.D., Ph.D.

Electrodesiccation *versus* Radiotherapy in the Treatment of the Basal-cell Epithelioma of the Skin. Gustave Archambault and Albéric Marin. *Canadian Med. Assn. Jour.*, June, 1930, XXII, 829.

Fifty-three cases are reported, of which 21 were treated with X-ray and 32 with electrodesiccation. The end-results were practically the same, each type of treatment yielding 91 per cent cures and 9 per cent failures. The X-ray treatment comprised curettage of the lesion under ethyl chloride local anesthesia, followed immediately by one massive X-ray treatment—two or three skin units. The factors for a skin unit employed were 100 K.V., 2 ma., 8 in. skin-to-target distance, no filtration, a Coolidge tube, 3 minutes. For electrodesiccation the monopolar current of Oudin was used. The electrode was held near the lesion, a noiseless spark of fairly strong intensity being used.

L. J. CARTER, M.D.

### SKULL (DIAGNOSIS)

Radiographic Researches of Technic of Anatomy and of Semeiotics of the Pars Petrosa. Arduino Ratti. *La Radiologia Medica*, August, 1930, XVII, 916.

This is a systematic study of the pathological and normal anatomy of the pars petrosa,

with the purpose of finding the points on which the radiologist must focus his attention, and with the idea of determining the best technic to follow. The author used a cadaver and practised experimental alteration of the zone. A detailed discussion of the results is given, and as far as the technic is concerned, the author prefers the sagittal antero-posterior projection.

L. MARINELLI.

The Importance of Encephalography for the Diagnosis and Therapy of Infantile Paralysis. Ludwig Guttmann. *Med. Klin.*, June 13, 1930, XXVI, 886.

Encephalography can give the clinician a picture of the anatomical formation in cases of infantile paralysis, if its limitations are remembered. A more exact diagnosis, *intra vitam*, can thereby be achieved. The author distinguishes four groups into which he classifies cases according to the roentgen findings: (1) Hemiatrophia cerebri, with porus formation; (2) atrophie cerebri, without porus formation; (3) primary malformation of the brain; (4) meningopathic processes.

The author claims that an encephalogram will in most cases allow of a differential diagnosis between these four groups.

H. W. HEFKE, M.D.

Intracranial Calcification and its Roentgenologic Significance. John D. Camp. *Am. Jour. Roentgenol. and Rad. Ther.*, June, 1930, XXIII, 615.

The author reviews the records of 781 verified brain lesions at the Mayo Clinic, and finds that only 7.6 per cent have produced calcification of sufficient degree to be detected roentgenologically. Physiologic or normal intracranial calcification occurs in the pineal gland oftenest, and less commonly in the choroid plexus, falx cerebri, and pacchionian bodies. Pathological conditions which may give rise to calcification are tumors, hematomas, tubercles, aneurysms, old abscesses, and areas of old meningitis or encephalitis. Neoplastic tumors showing calcification oftenest are gliomas, endotheliomas, suprasellar cysts, heman-

giomas, dermoids, and cholesteatomas. From the character and location of the calcification and the pressure effects upon adjacent bony structures, a roentgenologic differentiation is at times possible.

A number of illustrations of physiologic and pathologic calcifications are included in the article.

J. E. HABBE, M.D.

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**Trauma and Calcification of the Cerebral Falx.** Giorgio Betocchi. *Rivista di Radiologia e Fisica Medica*, January, 1930, II, 49.

The author has observed calcification of the cerebral falx in two patients who had head injuries. One of these had optic neuritis and both of them had chronic oto-maxillo-ethmoiditis. He assigns a pathogenic part to this inflammation, especially if there is antecedent syphilis, and thinks that the trauma plays an indifferent rôle.

E. T. LEDDY, M.D.

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**Encephalography in Cases with Fixed Lesions of the Brain.** Bronson Crothers, Edward C. Vogt, and R. Cannon Eley. *Am. Jour. Dis. Child.*, August, 1930, XL, 227.

This paper is concerned chiefly with a comparatively large group of neurologic cases found in children, namely, those with cerebral damage. The authors outline their technic in detail, and, although they respect the manometric values set by Pancoast and Fay, they tend to rely more on eyeground changes and cracked pot percussion notes, during the injection of air. A number of films are included from a series of 200 consecutive cases. In 50 per cent of the cases, encephalograms suggested cerebral atrophy. As an admittedly severe and probably dangerous procedure, the authors know of no case in which its use has led to an aggravation of previously existing disorders. One case of death of a child with an advanced glioma is given in detail.

In conclusion, the conventional diagnoses of feeble-mindedness, epilepsy, and cerebral palsy do not define the anatomical lesions or the physiologic residue, nor do they suggest logical

educational programs. The traditional period of hospital observation, investigation of the blood, spinal fluid, and routine roentgenograms of the skull, have given little information of definite value. Encephalograms, properly taken and intelligently interpreted, give definite information in at least half of properly selected cases, and negative facts of importance can be established in the remainder. Decisions should not be made on the basis of encephalograms alone, but the authors believe in this method before final judgment is passed upon the future of children severely handicapped by fixed cerebral lesions, unless less severe methods are demonstrably adequate.

F. B. MANDEVILLE, M.D.

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**Angioma Racemosum in the Skull.** L. Frigýér. *Röntgenpraxis*, July 1, 1930, II, 619.

Because only two similar case reports could be found, the author reports the clinical and roentgen findings of a case, that of a male patient who had a large nevus over the left side of the face and symptoms attributable to a left-sided brain lesion. The X-ray film showed a large area of calcified vessels in the skull, which was considered to be a partly calcified intra-cranial angioma.

H. W. HEFKE, M.D.

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**Studies in Pneumo-encephalography.** Frederic J. Farnell, Seth F. H. Howes, and Jessie B. Hudson. *Rhode Island Med. Jour.*, August, 1930, XIII, 115.

Since the simplification of the method of air injection by its introduction *via* the spinal route without the use of an anesthetic, a procedure of great diagnostic value has been placed within the reach of the clinicians and one which carries with it a comparative safety and the greatest simplicity. This report is based on twenty-five patients examined by this method and includes traumatic psychosis (one), senile psychosis (two), dementia præcox (three), epileptic psychosis (five), epidemic encephalitis (three), dementia paralytica (seven), hysteria (one), narcolepsy

(one), mid-brain disease (two), undetermined (one). In the series, dementia præcox, epilepsies, and hysterical psychosis gave little or no changes in ventricular shadows. The epidemic encephalitis, dementia paralytica, and senile disorders presented changes in their ventricular systems and pia-arachnoidal pathways. Further observations of such cases may lead to valuable conclusions.

W. W. WATKINS, M.D.

**Intracranial Pressure: The Correlation of Choked Disc and Roentgenologic Pressure Signs.** Frederic Schreiber. *Am. Jour. Roentgenol. and Rad. Ther.*, June, 1930, XXIII, 607.

An attempt has been made to correlate the clinical findings of choked disc, indicating increased intracranial pressure, and the roentgenologic demonstration of the same condition. The X-ray appearances in positive cases were graded slight, moderate, and marked, the estimate being based on the number and depth of convolutional impressions, atrophy of bone at the base and about the sella, and separation of sutures.

In no cases in which pressure symptoms were of less than two months' duration were there any X-ray findings of increased intracranial pressure. The rapidly invasive tumors, which were accompanied by the highest percentage of choked disc, showed the lowest percentage of X-ray pressure signs. The slowly invasive group of tumors (astrocytomas) showed the highest percentage (57) of roentgen signs of increased intracranial pressure, but 86 per cent of these also showed choked disc.

J. E. HABBE, M.D.

**Traumatic Pneumocephalus: Report of Eight Cases.** Carl W. Rand. *Arch. Surg.*, June, 1930, XX, 935.

The term "traumatic pneumocephalus" may be broadly used to designate the entrance of air into the brain or cranial cavity following a fracture of the skull. This occurs particularly in those cases of fractures of the skull which communicate with the paranasal sinuses, es-

pecially the frontal sinus. It may occur immediately or within several weeks following the injury. If evidence of air is found, an operative repair of the dural rent should be attempted. The diagnosis is made in practically all cases by means of the roentgen examination, which discloses not only the amount of air present but its location.

Eight cases are reported in this communication and of these three patients died of meningitis. One of these cases had been operated upon after meningitis had become general. In five other operative cases there was complete recovery following closure of the opening in the dura.

HOWARD P. DOUB, M.D.

**Indirect Signs of Brain Tumor as Noted in Routine Roentgen Examinations: Displacement of the Pineal Shadow: A Survey of 3,000 Consecutive Skull Examinations.** Cornelius G. Dyke. *Am. Jour. Roentgenol. and Rad. Ther.*, June, 1930, XXIII, 598.

A review of 2,724 routine skull roentgenograms and their subsequent case histories was made by the author to determine the significance of the reliability of pineal gland displacement. The gland was visible because of calcium content in 51 per cent of the total number, or 59 per cent of the patients over twenty years of age. Displacement, as determined by the method of Vastine and Kinney, was present in 39 per cent of all verified intracranial tumors, the most frequent displacement being in gliomas, which, in 56 per cent of all cases showed displacement, and meningiomas, 43 per cent of which showed pineal displacement. Fourteen per cent of not definitely proven pathologic cases showed pineal displacement, but a certain percentage of this group, the author believes, probably represents actual tumor pathology which, however, is not yet proven by operation or necropsy. The intracranial tumor apparently always displaces the pineal gland away from the pathologic side if displacement does occur, except in pituitary gland lesions.

J. E. HABBE, M.D.

### SKULL (THERAPY)

**Treatment of Acute Head Injuries.** Antonio D. Young. *Jour. Oklahoma St. Med. Assn.*, June, 1930, XXIII, 184.

The treatment of head injuries causes more anxiety than almost any other emergency of practice. Upon admission to the hospital, if shock is present, this is to be treated first. Immediate surgical treatment is usually necessary only for superficial hemorrhage or scalp laceration; all further surgery can wait until recovery from shock, when a more accurate diagnosis of the case can be made.

When the patient's condition warrants, X-ray examination of the skull should be made, with a sufficient number of films to give details of the nature and site of the fractures, if any be present. Rarely has a patient ever died of a fractured skull; he dies because of hemorrhage, brain destruction, or intracranial pressure. Every minute saved in beginning treatment of a severe case of head injury increases the chances of survival. Too often, valuable time is lost in waiting for unnecessary roentgenograms, while the patient's shock and intracranial pressure go unattended. The patient will survive or succumb independent of fractured skull, so early X-ray films are not necessary. Following recovery from shock, the next essential step is to make the X-ray examinations completely and thoroughly.

W. W. WATKINS, M.D.

**The Radical Treatment of Traumatic Epilepsy and its Rationale.** Wilder Penfield. *Canadian Med. Assn. Jour.*, August, 1930, XXIII, 189.

Localization of the site from which an attack of focal epilepsy arises can rarely be determined by neurological examination alone. In an analysis of convulsive patterns it is necessary to borrow from the observations of physiological experimenters. The author analyzes from this viewpoint the phenomena produced by lesions in various areas, *viz.*, the precentral gyrus, the frontal adverse field, the occipital eye field, the temporal adverse field, and the island of Reil.

The most important diagnostic measure is encephalography, or roentgenography of the brain after spinal air insufflation. By this means it is possible to demonstrate cysts which connect with the ventricle or the subarachnoid space, to determine cortical atrophy, and to discover the size, shape, and position of the ventricles. Localized brain scars are associated with wandering of the ventricles toward the site and side of the lesion.

Four interesting case reports are given in detail, three from the neurological service of the Royal Victoria Hospital, Montreal, and one from the service of the Presbyterian Hospital, New York City. In each case, methods of examination are given in detail and the radical treatment employed is described. In three cases, operation was done under novocain analgesia, and the hemispheres were explored electrically during the operation.

In Case I there had been a depressed fracture of the left frontal bone seven years previously. The lesion being localized as in the left frontal area, the left frontal lobe was excised, with good results. There have been no convulsions in the year that has elapsed since the operation.

In Case II a diagnosis of a contracting scar in the right cerebral hemisphere was made. There was a history of fracture of the parietal bone ten years before, convulsions beginning two years after the accident. At the operation multiple lesions were found in the right motor and temporal areas, and a portion of the scarred area was removed. There has been mental improvement and comparative freedom from attacks in the year following operation.

In Case III there had been a depressed fracture of the right frontal bone three years previously. Epileptiform convulsions began three years after the accident. X-ray examination showed the anterior horns of both lateral ventricles, as well as the third ventricle, to be displaced somewhat to the right. At operation an extra-cerebral cyst was found over the right frontal area, the anterior part of the right frontal lobe was hard-



ened and yellowish in color, with adhesions to the dura and to the adjoining hemisphere of the opposite side. This lobe was amputated. In the thirty months which have elapsed since operation there has been no recurrent attack.

In Case IV there had been a depressed fracture of the right side of the skull, followed in four months by epileptiform seizures. X-ray examination showed moderate enlargement of the right ventricle and a deflection of the whole ventricular system to the right side. At operation the right dura was found to be densely adherent. This was removed with the underlying brain. There was good recovery for six months, when the attacks returned.

L. J. CARTER, M.D.

### SPINE (DIAGNOSIS)

**Hypertorsion of the Child's Cervical Spine in the Roentgenogram.** E. Kehrer. *Strahlentherapie*, 1930, XXXVII, 609.

It is stated that the cervical spine of children permits an extensive torsion of the head, much more than in an adult. This fact must be considered in diagnosing the intra-uterine position of an embryo as shown on roentgen examination, in order to prevent errors in interpretation. Certain changes in position can be brought about by external forces, as, for instance, changes in position of the delivering woman. A number of cases are briefly reported, accompanied by roentgenograms of the pelvis, illustrating the author's contention.

ERNST A. POHLE, M.D., Ph.D.

**A Contribution to the Study of the Significance of Some Particular Alterations of the Vertebrae.** Desiderio Perotti. *La Radiologia Medica*, August, 1930, XVII, 932.

The author describes seven cases in which clinical symptoms led to a diagnosis of spondylitis. The radiological investigation revealed anomalies of the limiting surfaces of the vertebrae, and spherical-shaped depressions which presented some of the cartilaginous nodules

described by Schmorl. These lesions are regarded as of tuberculous origin, and must be interpreted as either initial stages of vertebral decay or as isolated areas of the tuberculous process surrounded by calcification of the bone in which they are located. In the opinion of the author the most important signs of early spondylitis are Schmorl's nodules and the enlargement of the inter-vertebral spaces, with irregularities of the limiting surfaces.

L. MARINELLI.

**X-ray Observations in Low-back Injuries.** James C. Johnston. *Jour. Oklahoma St. Med. Assn.*, April, 1930, XXIII, 114.

Although many back injuries will show no visible changes in the bones, at times evidences which are significant may be found. Particular care should be taken to examine the fifth lumbar vertebra and its articulations for slight changes shortly after injury, and for subsequent bone deposits indicating ligament and joint injury. If the type of trauma applied and the direction of the force are borne in mind, it will assist in making and interpreting roentgenograms.

W. W. WATKINS, M.D.

**The Differential Diagnosis of the Pain of Angina Pectoris and the Radicular Syndrome of Hypertrophic Osteo-arthritis of the Spine.** Don C. Sutton. *Illinois Med. Jour.*, September, 1930, LVIII, 202.

In the presence of hypertrophic osteo-arthritis of the spine, angina pectoris should be diagnosed when (1) the attacks follow effort and are of short duration after rest; (2) the individual with an anginal attack, regardless of its mildness, has a fear of continuing effort and stops of his own accord; (3) attacks following a heavy meal disappear after the stomach is emptied; (4) nocturnal attacks are of similar short duration and a history of pain following effort can be obtained; (5) anginal attacks always disappear after the giving of nitrites to full physiological effect.

The referred pain of nerve-root pressure in hypertrophic osteo-arthritis should be diagnosed when (1) pain is increased by move-

ments of the spine and is steady in character; sharp, stabbing, or cutting pains may be felt at the periphery of nerve distribution; (2) the steady pain or ache is often felt most after exercise and is persistent for long periods; (3) carefully elicited history reveals similar pain on the right side and usually over other spinal nerves; (4) D  jerine's sign is present, especially after sneezing or coughing; (5) pain is often felt between the shoulder blades; (6) the X-ray shows evidence of hypertrophic changes in the bodies of the vertebrae. The nerve pain is hypertrophic osteoarthritis of the spine is never relieved by the administration of nitrites.

C. H. DEWITT, M.D.

**Myelomatosis in a Child of Eight Years.** Paul Jacoby. *Acta Radiologica*, 1930, XI, Fasc. 2, 224.

A case of myelomatosis of the spine is reported. The vertebrae showed a compressed structure and were markedly decalcified. At postmortem examination, the vertebrae were found to be masses of soft, reddish material, practically without osseous structure.

M. J. GEYMAN, M.D.

**An Analysis of One Hundred Consecutive Cases of Back Strain.** Myron O. Henry. *Minnesota Med.*, August, 1930, XIII, 572.

Study was undertaken to determine the relative frequency and importance of the various findings in cases of back strain occurring in private practice. Every case was studied with stereoscopic, antero-posterior, and lateral roentgenograms. Eighty per cent showed some sort of anatomic variation of congenital type. Abnormally placed postero-lateral articulations were found in 63 per cent of the cases. Sacralization appeared in 5 per cent and spina bifida in 7 per cent. Arthritic changes were shown in 5 per cent. This is a most bothersome condition to insurance companies, the expression "pre-existing dormant arthritis, aggravated by injury" having become very common. Most cases can be relieved by rest and mechanical support and fixation, al-

though fusion operations are sometimes required.

W. W. WATKINS, M.D.

**A New Radiographic Method for the Study of the Cervical Vertebrae.** Pietro Ottonello. *Anales de Radiologia*, April, 1930, II, 57.

The technic, as described by the author in radiographing the cervical vertebrae in the antero-posterior position, is as follows: The patient lies on the Bucky in the supine position, with the head slightly extended and held with a compression band, and the rays are centered on the chin, with the patient's mouth closed. (While the author gives specific radiographic factors, these, of course, can be changed in accordance with the technic used by the operator; the longer the exposure time, the better.) During the exposure the patient opens and closes his mouth rhythmically, while holding his breath, at a rate of once or twice per second.

Illustrations accompanying the article show that the movement of the lower jaw, while somewhat blurring the field covered by the mandible during movement, permits the visualization of all the cervical vertebrae, and the blurring does not seem to interfere with the diagnostic qualities of the film.

P. R. CASELLAS, M.D.

**The Klippel-Feil Disease.** A. J. Pytel and S. S. Chaievitch. *Vestnik Rentgenologii i Radiologii*, 1930, VIII, No. 1, p. 45.

The Klippel-Feil disease is an affection of the cervical vertebrae, characterized by shortening of the neck, limitation of motion of the head, and low limit of the hair on the back of the neck. The head appears to rest directly on the thoracic cavity. Roentgenologic investigation of the neck will often reveal complete fusion of the cervical vertebrae, giving the appearance of a single mass. The number of cervical vertebrae may be diminished. Occasionally a spina bifida may be discovered, and frequently other anomalous affections are found in the skeletal system. The etiological

factors of the disease are not known: most frequently it is of congenital origin.

The authors report four cases, all of them being in female patients. Photographs and roentgenographs accompany the paper.

SAMUEL BROWN, M.D.

**The Differential Diagnosis of Diseases and Post-traumatic Changes of the Vertebrae.** Hans Holfelder. *Röntgenpraxis*, Oct. 1, 1930, II, 865.

Diseases and post-traumatic changes of the vertebrae are the most difficult chapters in industrial surgery. It is possible to demonstrate all parts of the vertebrae on the film; an antero-posterior examination alone should not be considered sufficient, but a lateral film should always be taken. Stereoscopic films may be desirable in certain cases and are technically not difficult to obtain. The interpretation of roentgenograms of the vertebrae, especially in relationship to post-traumatic changes, is not simple, as entirely different causes may lead to the same anatomical changes. It is important, for insurance purposes, to have a roentgen examination of the vertebrae in every case of spine injury immediately after the accident. It is then possible to state in the future whether or not pathological changes were present at the time of the injury, or if they were sequences of it. Recent fractures of the vertebral bodies are usually easy to diagnose, but the diagnosis of fractures of the transverse processes are more difficult. A fracture of the transverse processes without dislocation has not been described in the literature, and we should hesitate to diagnose it unless some displacement is present. Occasionally it is impossible to demonstrate recent fractures of the arches. Secondary bone changes such as callus and deformities may lead to a diagnosis some time after the injury. Slight injuries of the vertebral bodies usually lead to later changes, especially arthritic and hypertrophic in character, which may cause considerable discomfort and pain. Such changes, however, may take place not only after injuries but also due to arthritis deformans. Clinical symptoms are often entirely absent even with marked roent-

genologic findings. The roentgenologic findings and the clinical symptoms do not always parallel each other. A generalized spondylitis deformans cannot be explained as caused by an injury. A localized spondylarthritis deformans, when found in the neighborhood of the injured area, should be considered as caused by an accident, as long as we do not know more about this disease.

In later stages of post-traumatic changes, many differential diagnostic difficulties present themselves. Congenital synostoses, and congenital deformities of the vertebral bodies may be mistaken for old fractures. However, the height of the body in these cases is normal in congenital abnormalities, and decreased after fractures. Cervical ribs, lumbar ribs, and anomalies in the region of the fifth lumbar and the first sacral vertebrae must sometimes be differentiated from post-traumatic changes. The narrowing of a body may be due to senile osteoporosis, or osteomalacia, or to Perthes' disease isolated in a vertebral body; also tumors and infectious diseases may lead to a narrowing and partial destruction. The differential diagnosis from a post-traumatic narrowing by the roentgen film alone is sometimes impossible. If one finds the contour of the vertebra in question, protruding over the neighboring vertebrae, one should think of a fracture rather than a metastatic or inflammatory process. Each case has its own problems, and we are still far distant from a satisfactory understanding.

H. W. HEFKE, M.D.

## THROAT (DIAGNOSIS)

**The Roentgen Examination in Diseases of the Trachea.** Max Sgalitzer. *Röntgenpraxis*, July 15, 1930, II, 636.

The X-ray examination is able to show pathological displacement and narrowing of the trachea better than any other clinical method. Such changes are most often caused in goiter patients. The value of the roentgen examination in determining the presence of a substernal goiter is well known. One examination which is not generally known is the test of the resistance of the tracheal wall by Val-

salva's and Müller's method (increase and decrease of the intratracheal air pressure). Tracheomalacia can thus easily be demonstrated. Not only goiters, but glandular tumors of the neck and mediastinum, aneurysms, lung tumors, tuberculosis, pneumothorax, and hydrothorax may lead to a displacement of the trachea. Aneurysms most often seem to displace the trachea laterally, and mediastinal tumors, anteriorly or posteriorly.

H. W. HERKE, M.D.

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### THYMUS (DIAGNOSIS)

**The Incidence of Widened Thymic Shadows in the New-born.** J. Victor Greenebaum, Leo S. Friedman, and Samuel Brown. *Jour. Med.*, February, 1930, X, 577.

Roentgenograms have been made of the thymus glands of all white babies born in the free wards of the Jewish Hospital, during the past five years, and 304 consecutive roentgenograms form the basis of this report. Only films taken when the baby was quiet are included. In the series 30.5 per cent showed widened thymic shadows. They regard a standardized technic as essential, if 3 cm. in the second interspace is taken as the upper limit of normal.

W. W. WATKINS, M.D.

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**Some Observations on the Thymus in Early Infancy.** E. H. Shannon. *Canadian Med. Assn. Jour.*, June, 1930, XXII, 775.

This study is an analysis from the findings contained in the radiography of the thymus glands of 219 infants. The technic employed was as follows: focal skin distance of 30 inches, 30 ma., 80 K.V., one-quarter second. The target must be centered accurately over the thymus at a point one inch below the suprasternal notch. Only normal cases were radiated, and from the series were excluded prematures and all cases presenting symptoms referable to the thymus. Measurements

of the thymus shadow were made, at the level of the third thoracic vertebra, of the total transverse diameter of the gland, and of the external diameter of the chest at the same level. The smallest thymus found measured 2.2 cm. and the largest 5.4 cm., the average of all cases being 3.2 centimeters. The average ratio of thymus to chest diameter was 1:22.

In a further series of 50 consecutive cases referred for examination or treatment, with more or less definite symptoms of thymic enlargement, the largest shadow was 4.6 cm. and the smallest 2.4 centimeters. The average size was 3.4 cm., and the average thymus-chest ratio was 1:207.

The conclusions reached from the study of the two series of cases are that the presence of a large thymus shadow on the X-ray plate has no direct or definite interpretation in terms of pathology or clinical symptoms, and that, therefore, clinical manifestations should be the sole index as to the advisability of treatment. While the discrepancy between the size of the gland and production of symptoms favors the endocrine theory of thymus disease, those who uphold the mechanical theory offer the obvious and irrefutable argument that where an apparently small gland appears to produce symptoms, there actually exists antero-posterior enlargement not demonstrable in the roentgenogram. The chief value of roentgenograms of the thymus in early infancy is to confirm an indefinite clinical diagnosis of enlarged thymus, or to check the results of X-ray treatment in reducing the size of the gland shadow. They are also of value in determining changes in the size of the gland in cases which show recurrence of symptoms.

In order to determine what changes take place in the size of the thymus gland in the first few days of life a further series of 33 cases were radiographed. The average size within 5 hours of birth was 3.7 cm., whereas the average three days later was 3.15 centimeters. Very little change was noted in size subsequent to the third or fourth day. The practical conclusion from this latter series was that the examination should be delayed until the third or fourth day after birth, unless there are urgent indications earlier. The

technic employed in X-ray treatment, where indicated, was as follows: focal skin distance 10 inches, 90 K.V., 5 ma., filtration of 4 mm. aluminum. Treatments are given alternately anteriorly and posteriorly over the gland area for four doses at weekly intervals. The only criteria of treatment are that it should reduce the size of the gland without being too heavy.

L. J. CARTER, M.D.

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**Thymic Shadows of New-born Infants.** H. B. Podlasky and S. E. Kohn. *Am. Jour. Dis. Child.*, April, 1930, XXXIX, 782.

One hundred consecutive new-born infants, less than twenty-four hours old, were studied. According to the authors, it was not always possible to obtain roentgenograms in the same phase of respiration. The so-called postero-anterior position in recumbency at full inspiration has been considered best by the authors. A standard technic at 30 inch distance, one-eighth second exposure, 55 K.V., and 25 ma. was used.

A mediastinum one and one-third times the width of the thoracic vertebræ, measured at the second thoracic level, was considered normal. By definitely enlarged, the authors mean a width at the second thoracic vertebra which proved to be more than twice that of the latter's transverse diameter.

With the above standards, 35 of the 100 infants showed definitely enlarged thymuses. None of the symptoms usually referable to thymic enlargement was evident in the 35 cases described.

The authors mention that great variation has been found in the size of the thymus between recumbent and upright positions, and in inspiratory and expiratory phases.

Lateral views were not included in this study, as suggested by Pancoast and Pendergrass, in their recent work.

F. B. MANDEVILLE, M.D.

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**Hyperplasia of the Thymus: A Study of 1,045 Patients Including Available Family**

**and Maternal History.** Sam W. Donaldson. *Am. Jour. Roentgenol. and Rad. Ther.*, November, 1930, XXIV, 523.

The writer emphasizes the importance of an early diagnosis of hyperplasia of the thymus. The diagnosis and treatment of an enlarged thymus is a problem of the radiologist. The author has found satisfactory results in the treatment by using the small fractional dose method, the average case receiving three or four treatments.

He emphasizes the belief that enlargement of the thymus appears to belong to family groups. Roentgen examination is indicated in all children in whom a familial history of enlarged thymus in the children is obtained. Certain cases of thymic enlargement do not decrease in size after irradiation but the symptoms subside. There is only unconvincing evidence that there may be a relation between enlarged thymus in the offspring and thyroid disturbance in the mother. While there is some evidence that larger babies are more apt to have enlargement of the thymus than the smaller ones, this is not enough to limit investigation to the larger babies only. The finding of an enlarged thymus shadow was slightly more common in females in this series of cases.

J. E. HABBE, M.D.

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## THYROID (DIAGNOSIS)

**Hyperparathyroidism.** John de J. Pemberton and Kenneth B. Geddie. *Ann. Surg.*, August, 1930, XCII, 202.

A case of hyperparathyroidism in a girl fourteen years of age, due to excessive parathyroid secretion caused by parathyroid adenoma, is presented in detail. Hypercalcemia, hypophosphatemia, progressive weakness, loss of muscular tonus, abdominal pain, vomiting, anemia, polydipsia, polyuria, and decalcification of the skeleton, are the main symptoms.

In the authors' case roentgenograms of all of the bones presented evidence of a diffuse decalcification without loss of the normal structure of bone. Films of the skull vault, pelvis, and knees are included in the paper. Roentgenograms taken four weeks after the

removal of the parathyroid adenoma did not reveal any increase in the density of the bones. The clinical symptoms were improved.

The literature on the parathyroid glands since their discovery by Sandstrom is reviewed by the authors. The possible relationship of hyperparathyroidism to osteomalacia, osteitis fibrosa, rickets, and tetany is discussed.

F. B. MANDEVILLE, M.D.

**The Clinical Syndrome of Hyperparathyroidism.** David P. Barr and Harold A. Bulger. *Am. Jour. Med. Sci.*, April, 1930, CLXXIX, 449.

Hoffheinz was able to collect 45 cases in which parathyroid tumor or hyperplasia was certain between the years 1900 and 1925. To this number the authors have added 29 more. These include both malignant and benign tumors, as well as enlargement due to simple hyperplasia.

The symptoms of clinical hyperparathyroidism are similar to those produced by the experimental injection of excessive amounts of parathormone, *i. e.*, hypertonia and diminished electrical excitability of muscle, decalcification of bones, hypercalcemia, and abnormal excretion of calcium in the urine. Hypercalcemia is the most significant clinical sign in the diagnosis of hyperparathyroidism and usually indicates increased function of the parathyroid glands.

There is apparently a direct relation between tumors of the parathyroids, with increased function, and generalized osteitis fibrosa cystica (von Recklinghausen's disease), as 32 of these patients suffered from a generalized form of osteitis fibrosa cystica. Nine others were diagnosed as osteomalacia. A number of the cases collected by the authors showed marked improvement, with a definite decrease in the serum calcium after the removal of the parathyroid tumors. The authors feel that in generalized osteitis fibrosa cystica the clinical picture of hyperparathyroidism is most frequently encountered; it may possibly be primary and is unquestionably harmful. The determination of calcium and phosphate content of the serum should be

made in all cases of generalized bone disease, not only as a matter of interest but because of their therapeutic indications.

ROE J. MAIER, M.D.

## THYROID (THERAPY)

**Special Points in the Treatment of Diseases of the Thyroid Gland.** C. C. Higgins. *Journal-Lancet*, March 1, 1930, L, 99.

In connection with the treatment of exophthalmic goiter, the author estimates that of the two thousand or more patients observed yearly more than one-half have hyperthyroidism. During the past two years, X-ray treatment has been used on many of these. The main argument against this treatment is the importance of the time element, during which interval visceral changes may develop. He does not advocate X-ray treatment as the primary form of therapy in many cases.

W. W. WATKINS, M.D.

**Roentgen Treatment of Toxic Goiter.** E. Hayer and W. Hufschmid. *Strahlentherapie*, 1930, XXXVI, 477.

Roentgen treatment of toxic goiter has been very satisfactory in the medical clinic of the University of Kiel. Three fields of exposure were used, one each over the left and right lobe of the thyroid and one over the thymic area. Technic: 150 to 180 K.V., 4.0 Al or 0.5 copper; half value layer in copper = 0.3 or 1.15 mm.; initial dose approximately 60 r. If this was tolerated well, 90 to 120 r were given after 14 days, and 150 or 180 r two or three weeks later. In most cases only one field per day was exposed. Of 47 patients who were treated one year previous to this report, 21 are free of symptoms and improved, 7 show no improvement, 6 died, 6 were operated on, and 7 could not be traced. Of 57 patients who were under treatment longer than three months, 10 are free of symptoms, 29 are improved, and 16 are unimproved. One patient died and one did not return for further treatment. Of 19 patients who have been

under treatment less than three months, 15 are improved, 3 not improved, and 1 could not be traced.

The author makes the recommendation that X-ray therapy be given a trial in all cases of toxic goiter, unless alarming symptoms demand immediate operation.

E. A. POHLE, M.D., Ph.D.

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**Malignant Tumors of the Thyroid Gland.** Carrington Williams. *Virginia Med. Monthly*, July, 1930, LVII, 228.

In treating malignant tumors of the thyroid gland, remember that many of them arise in pre-existing adenomas. All nodular goiters should be removed. When the cervical lymph nodes are involved the condition is usually inoperable, but not always so. Following operation, very thorough treatment by X-ray is advised, regardless of the possibility of hypothyroidism. The inoperable cases may derive considerable relief from radium and X-ray, and should be so treated.

W. W. WATKINS, M.D.

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**Our Method of X-ray Therapy of Basedow's Disease in Older Women.** Anna Jugenburg. *Strahlentherapie*, 1930, XXXVI, 491.

The author observed five deaths among 160 patients with Basedow's disease whose histories are briefly related. In addition to the usual exposure of the thyroid and thymic region the hypophysis was also irradiated by filtered roentgen rays of short wave length. *Technic:*  $6 \times 8$  sq. cm. field, one each over the left and right temporal, one over the occipital, and one over the frontal region, 242 r per field. In one sitting there was only one field given, the next one at from 1 to 2 days' interval.

The author arrives at the conclusion that Basedow's disease in older women takes a more severe course. The disturbance in the endocrine system is caused by changes in the ovaries, thyroid, and hypophysis. In all cases where exposure of the thyroid alone does not

lead to improvement the hypophysis is irradiated next. This therapy is also indicated in younger women suffering from Basedow's disease, if a hyperfunction of the hypophysis is probable.

E. A. POHLE, M.D., Ph.D.

## TUBERCULOSIS (DIAGNOSIS)

**The Diagnosis of Early Ileocecal Tuberculosis: A Preliminary Report, with Special Reference to the Double Contrast Enema.** J. Gershon-Cohen. *Am. Jour. Roentgenol. and Rad. Ther.*, October, 1930, XXIV, 367.

This report is intended to set forth the technique and to emphasize the value of the "double contrast colographic" studies of ileocecal tuberculosis. Without special preparation, an opaque mixture, such as is in common use, is first injected into the colon under roentgenoscopic control, paying special attention to spasm and irritability of the colon, particularly on the right side. Mass peristalsis, anastalsis, competency of the ileocecal valve, outline of the colon, ileocecal valve, and terminal ileum, the presence or absence of pain and tenderness over any segment of the colon, the distribution, form, balancing, and the peristaltic changes of the haustra, the mobility of the cecum and ascending colon, and the constancy of irregularities are noted. Roentgenographic examinations are also made and the patient is permitted to evacuate the opaque contents. This is followed by another intermediary roentgenoscopic examination and the distribution of the residual contents noted. Mass peristalsis of a residual column in any colonic segment is looked for at this time. The colon is then slowly inflated with air, using a Pultizer bag with a ball-valve. The roentgenoscopic examination is then repeated. The author considers this method more valuable in arriving at an earlier and more definite diagnosis. These studies are made with greater dispatch and less annoyance to the patient than when the serial meal method is used. They require fewer exposures than the serial examinations, and when repeated at regular intervals are of precise prognostic value. fur-

nishing an index of therapeutic progress. The article is well illustrated.

J. E. HABBE, M.D.

**Tuberculosis of the Knee Joint, Demonstrated by Oxygen Injection into the Joint.** B. Ulrichs. *Röntgenpraxis*, Sept. 15, 1930, II, 817.

The diagnosis of tuberculosis of the knee joint often offers considerable difficulty. The injection of oxygen into the joint occasionally assists in making possible a better diagnosis and may also be of therapeutic value. The author has never encountered any accidents caused by the injection, although he has used it in over two hundred cases. The technic of this procedure is that of Wollenberg. Good roentgenograms and short descriptions of some cases indicate the usefulness of this method in selected cases.

H. W. HEFKE, M.D.

**Roentgen Diagnosis of Pulmonary Tuberculosis in Infants and Children.** Rolla G. Karshner. *California and Western Med.*, August, 1930, XXXIII, 565.

The roentgenogram will show a pneumonic infiltration of moderate extent which may occur in any lobe. It may be multiple. More frequently the healed remains of the primitive infiltration are detected, though in the greater number of cases it becomes invisible because of its size. Often it is represented only by a strand of fibrous tissue, generally in an upper lobe. Not infrequently the pleura in the region of the site of the initial lesion is involved, leaving a sharp linear shadow extending from the hilum to the periphery. Before pathologic studies revealed the frequency of pulmonary infection in the early months of life, with increasing infection year by year, tuberculosis in infancy was regarded as almost invariably fatal. We now know that even in infancy an advanced tuberculous process may heal.

In the diagnosis of tuberculosis of the intrathoracic lymph nodes, the roentgenogram is indispensable. The diseased lymph nodes, in all their variety of size, shape, and position, are projected as dense shadows extending be-

yond the mediastinum into the pulmonary field. Lateral views of the chest are essential.

In children, the problem of diagnosis of tuberculous hilum glands becomes more difficult. It can rarely be stated from the roentgenogram whether or not disease of the intrathoracic lymph nodes is the cause of the child's symptoms. There may be no correspondence between the size of the glands and the severity of clinical symptoms. Neither can enlargement of the tuberculous nodes always be distinguished from moderate tumefaction of hyperplastic lymph nodes, particularly in the absence of caseation or calcification.

Hilum tuberculosis is a much more common form of the disease in early adult life, yet but for the roentgenogram it would usually be undiscovered. The process originates at the root of the lung and extends outward a variable distance.

In infants, it consists of a cheesy tuberculosis of the lung root tissues, rapidly progressive, with a bad prognosis. The triangular shadow of ordinary infantile pneumonia has its base at the periphery, whereas in hilum tuberculosis it is at the root. In the author's experience it was nearly always right-sided.

This may be a terminal phenomenon in any type of tuberculosis. In rare instances it is purely pulmonary, the infiltrations not regular in distribution, and there may be caseation or fibrosis. This type occurs secondary to an older lesion in the lungs and may develop after the age of infancy. The first symptoms frequently follow closely upon measles or whooping-cough. The disease occasionally heals, though it is usually fatal.

F. B. SHELDON, M.D.

**Tuberculosis in Children.** Henry D. Chadwick. *New England Jour. Med.*, May 29, 1930, CCII, 1044.

The diagnosis of tuberculosis in children depends upon consideration of the history, symptoms, physical signs, tuberculin test, X-ray evidence, and exclusion of other causes for symptoms.

"An X-ray is indispensable in the examination of a child's chest. Without it a positive diagnosis of the childhood type of tuberculo-



sis cannot be made. Furthermore, a physician, however good a clinician he may be, is not justified in excluding tuberculosis without checking his physical examination of the chest with the evidence that only an X-ray film can give."

The two types of lesions to be looked for in the roentgenogram are: (a) the parenchymal, which may be nodular or diffuse, and (b) the tracheobronchial, which may be seen as masses along the trachea, the main bronchi, or their larger subdivisions. One or the other, or a combination of both, may be present.

W. W. WATKINS, M.D.

Pulmonary and Secondary Intestinal Tuberculosis: A Correlative Study. Eli H. Rubin. *Am. Rev. Tuberc.*, August, 1930, XXII, 184.

The author gives detailed reports on the presence of intestinal and laryngeal tuberculo-

sis found in the course of five hundred autopsies on patients who had died of pulmonary tuberculosis.

Approximately 65 per cent of patients who had died of chronic pulmonary tuberculosis between the ages of 31 and 50 years had intestinal tuberculosis also, and laryngeal tuberculosis was found in 45 per cent. A much larger percentage of intestinal and laryngeal involvement was found in the caseous than in the fibrotic types. From a study of this series, the author found well developed, complete healing in the intestinal involvements, which, to his mind, refutes the idea long held that such a complication bars all chance of recovery.

The article, as a whole, gives valuable data on the subject and teaches the necessity of further examinations than of the chest alone in pulmonary tuberculosis.

S. C. BARROW, M.D.



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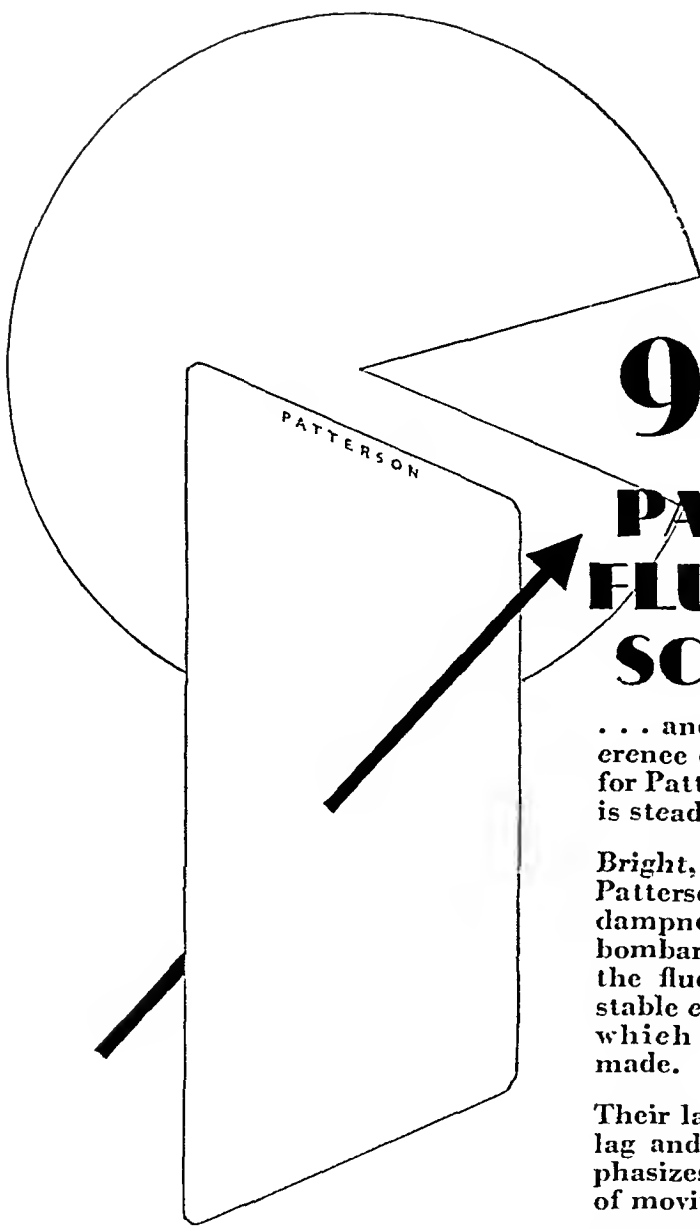
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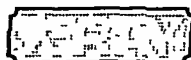
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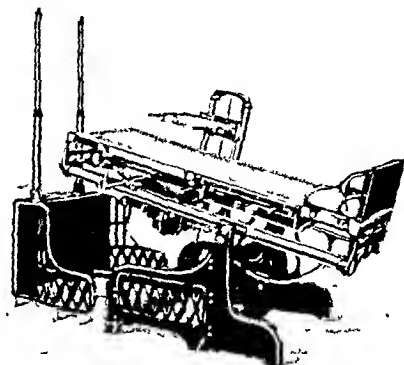
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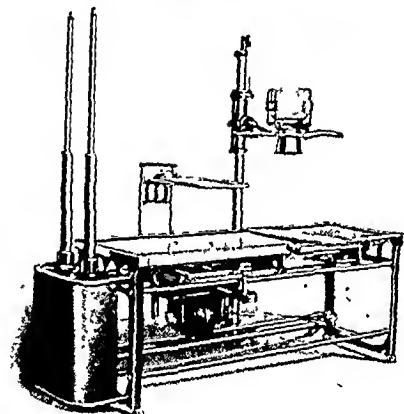


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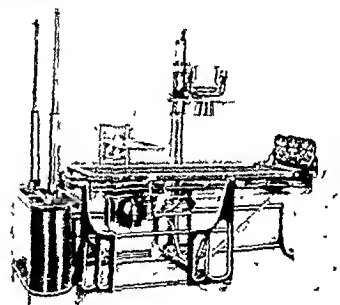
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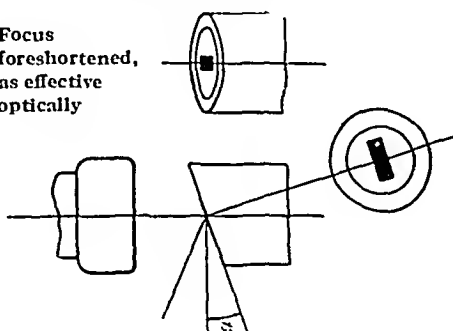
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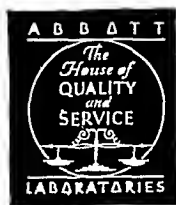
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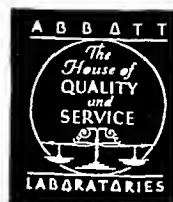
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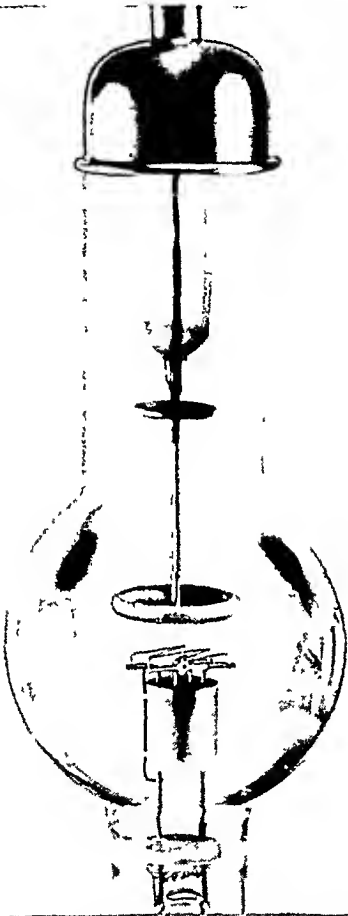
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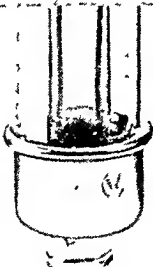
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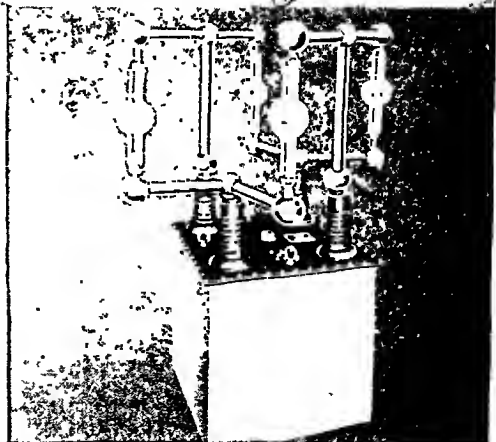
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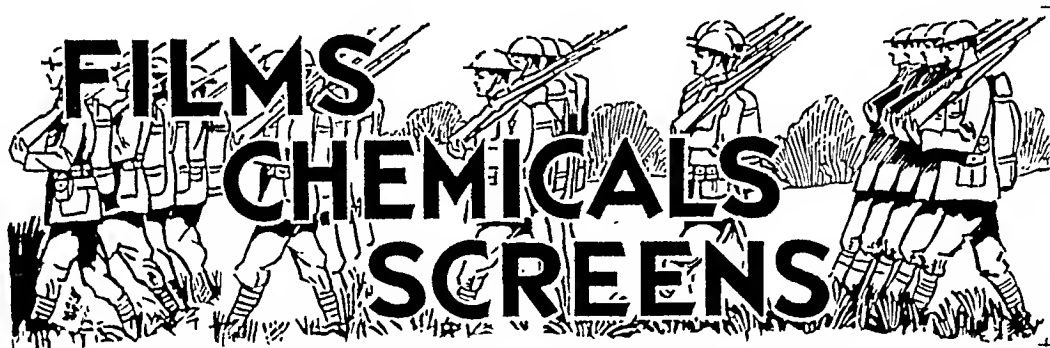
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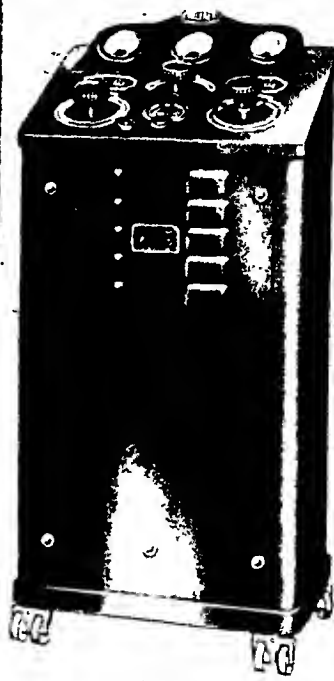
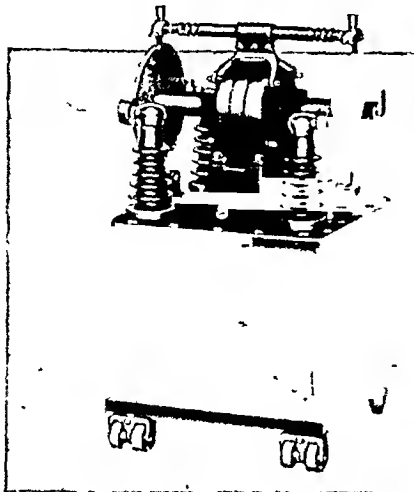
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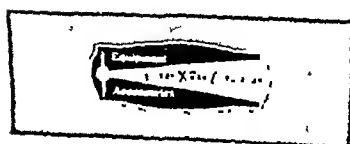
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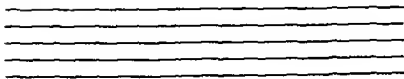
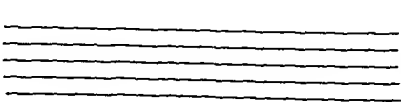
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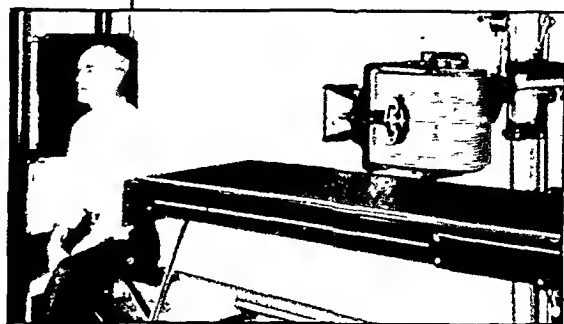
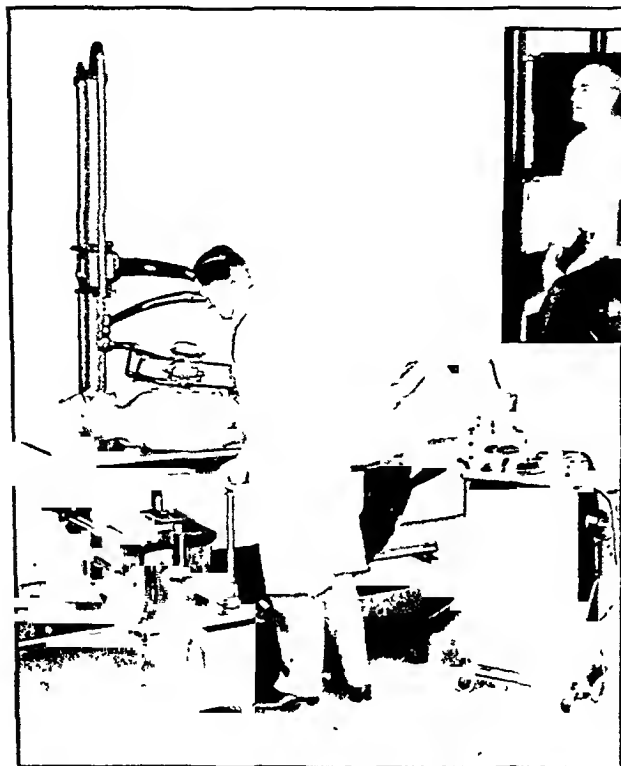
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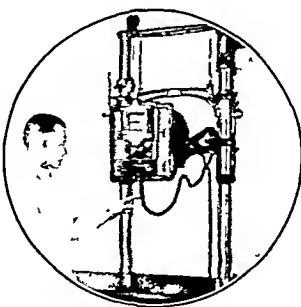


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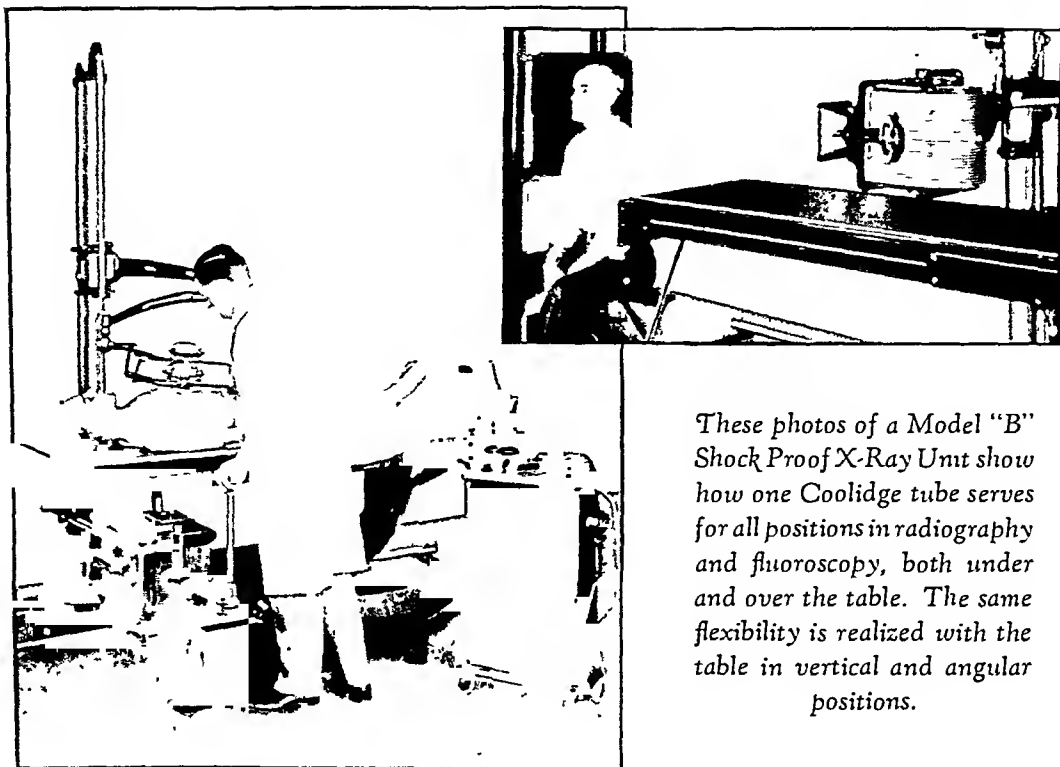
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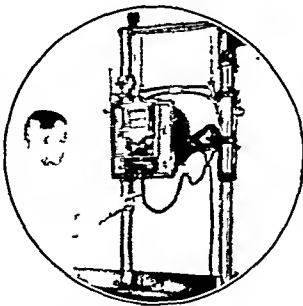


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## THE ROENTGENOLOGIC DIAGNOSIS OF BONE TUMORS

By CHARLES F. GESCHICKTER, M.D.

Surgical Pathological Laboratory, Johns Hopkins Hospital and University, BALTIMORE

### INTRODUCTION

**S**UCCESSFUL medical diagnosis is dependent upon a twofold knowledge—familiarity with disease and information concerning the patient. Knowledge of disease implies an acquaintance with the so-called clinical entities, and knowledge of the patient presupposes a form of analysis known as a case history and physical examination, the latter elaborated in recent years by a series of laboratory and instrumental methods, including the use of the roentgenogram. Since diagnosis is essentially a disclosure in the patient of changes identical in character with those predetermined for a given disease entity, it is obvious that no single method of examining the patient, however helpful, can dispense with an adequate knowledge of disease.

In diseases of the bone the advent of the roentgenogram has added so much to the clinician's ability to bring to light the form and locality of the lesion, that this instrumental method has come to be considered by many, not as an adjunct to the examination of the patient, but as a new short-cut to diagnosis. While typical cases of bone disease may be diagnosed with fair readiness by direct comparison with previous X-ray films properly labelled, the variability of the pathology in the bone from patient to patient, with the same form of tumor, is suf-

ficiently great to render such a method inaccurate in cases of the borderline group. If those who employ the X-ray for diagnosis of diseases of bone wish to extend the reliability of this instrument to a larger percentage of bone lesions coming under observation, what is needed is not more and more reiteration concerning the typical X-ray picture of the various tumors of bone, but a more careful analysis on the one hand of the roentgen examination of bone, as a diagnostic instrument, and on the other, a more comprehensive knowledge of the separate neoplastic entities of bone.

As a diagnostic agent in tumors of the bone, the roentgenogram is of sufficient importance to justify the organization of present-day knowledge concerning tumors of bone, from the standpoint of the features disclosed by the X-ray film. Such an organization of the information derived from a study of over a thousand cases of the various forms of bone tumors has been made here and is based upon the capacity of the roentgenogram to depict changes in the seven groups of findings listed below.

(1) Whether the individual affected is young or old.

(2) Whether the lesion is single or multiple.

(3) Whether the lesion is medullary or periosteal in origin.

(4) Whether the effect of the lesion is bone-destructive or bone-formative.

the skeleton, whether they are more prevalent in patients under or over twenty, and

(5) Whether the site is in the shaft,

whether the bone lesion is primarily osteo-

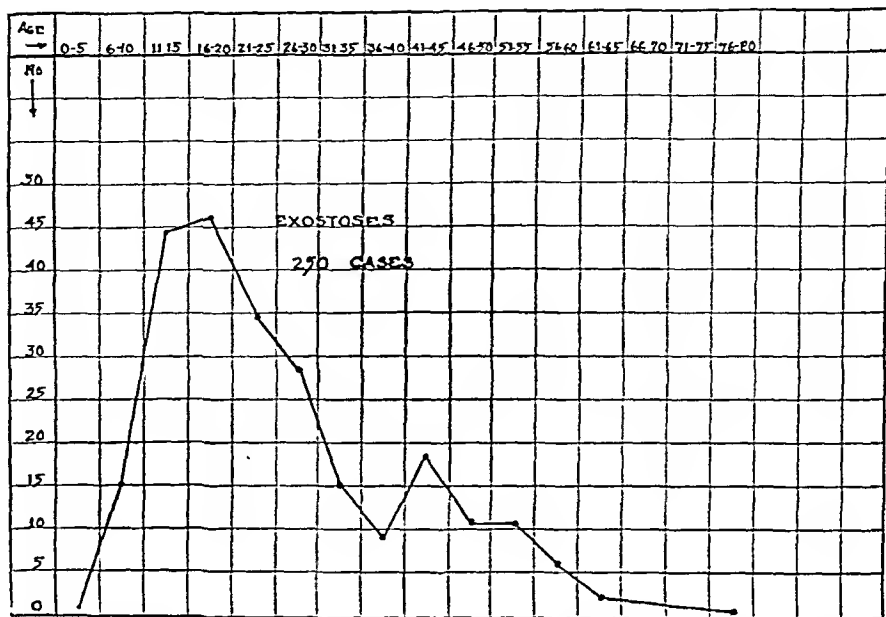


Fig. 2. Chart showing the age incidence of benign exostoses or osteochondromas.

metaphysis, or epiphysis, and which bone is affected.

(6) Whether or not pathologic fracture has occurred.

(7) The configuration of the diseased area from which such data as the mode of origin and duration of the tumor may be deduced.

A summary of the results of the study is shown by chart (Fig. 1) and by tabulation (Table I). These diagrammatic representations are followed by a series of brief descriptions of the various neoplastic entities of bone, with representative illustrations. From the standpoint of differential diagnosis, bone diseases not of neoplastic nature have been included. As will be seen by the chart and from the sectional headings, the various tumors of bone have been grouped on the basis of whether or not they produce single or multiple involvement in

lytic or osteoplastic in its effect. In the clinical descriptions which follow, something of the histogenesis of each tumor has been included, because a comprehension of the mode of origin of the neoplasm often permits an analysis of the X-ray film not otherwise possible. A list of the entities discussed is given below in the order of their frequency, with the number of cases analyzed in each group.

#### ORDER OF DISCUSSION

##### *Part A. Single Lesions*

#### I. Osteoplastic lesions prevalent in patients under twenty

1. Exostosis or osteochondroma
2. Periosteal osteogenic sarcoma
3. Ewing's sarcoma
4. Garré's sclerosing osteitis

#### Summary

## II. Osteolytic lesions prevalent in patients under twenty

1. Benign bone cyst
2. Osteogenic sarcoma of the osteolytic type
3. Brodie's abscess

### Summary

## III. Tuberculosis, syphilis, osteomyelitis, and myxosarcoma

1. Myxosarcoma
2. Osteomyelitis

Tuberculosis of bone

Syphilis of bone

## IV. Ossifying periosteal lesions prevalent in adults

1. Periosteal fibrosarcoma
2. Myositis ossificans
3. Ossifying periostitis.

### Summary

## V. Osteolytic lesions prevalent in adults

1. Benign giant-cell tumor
2. Chondroma
3. Metastatic carcinoma (single focus)
4. Latent bone cyst
5. Multiple myeloma (single focus)

### Summary

### Part B. Multiple Lesions

## I. Multiple osteoplastic lesions prevalent in patients under twenty

1. Multiple exostoses
2. Marble bones
3. Infantile scurvy

### Summary

## II. Multiple osteolytic lesions prevalent in patients under twenty

1. Metastatic osteomyelitis
2. Bone fragility
3. Rickets

### Summary

## III. Multiple osteoplastic lesions prevalent in adults

1. Osteitis deformans

## IV. Multiple osteolytic lesions prevalent in adults

1. Metastatic carcinoma

## EXOSTOSES

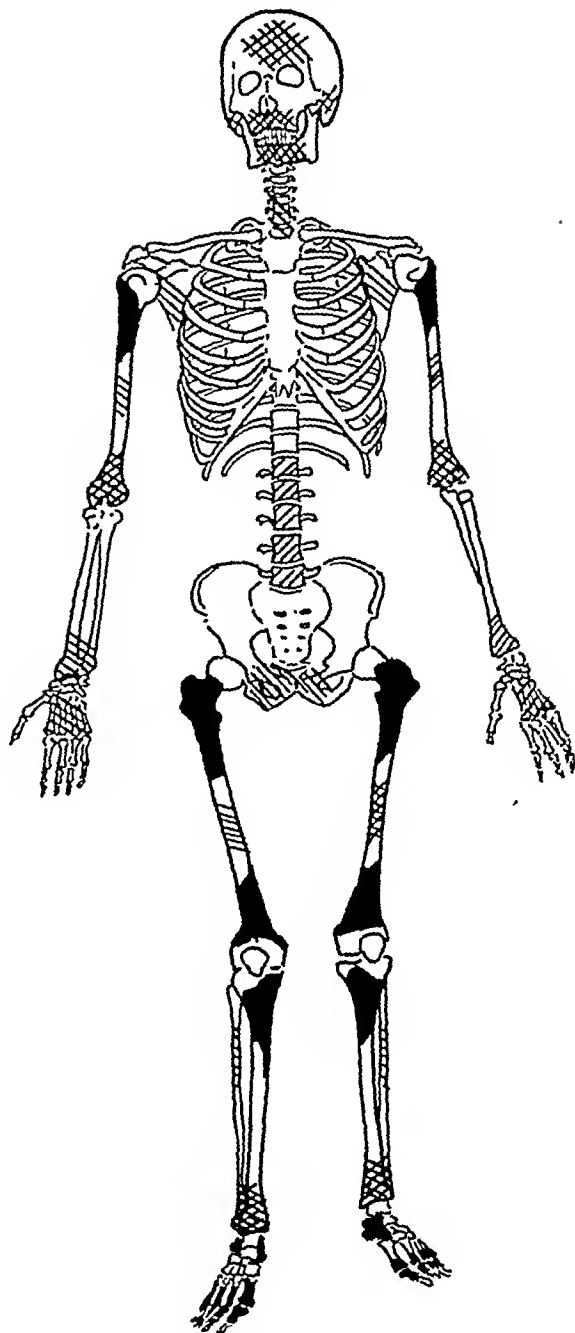


Fig. 3. Chart showing the incidence of benign exostoses according to skeletal location. The solid black areas indicate the most frequent sites; the checked areas, the common sites, and the diagonal line areas, the occasional sites.

2. Multiple myeloma

3. Osteomalacia

### Summary



TABLE I  
CLASSIFICATION OF BONE DISEASES AND BONE TUMORS ACCORDING TO ROENTGENOLOGIC FEATURES

| Age                |                     | Foci                |          | Distribution            |                     |                     |                    | Locus                   |                          | Effect                  |                          |
|--------------------|---------------------|---------------------|----------|-------------------------|---------------------|---------------------|--------------------|-------------------------|--------------------------|-------------------------|--------------------------|
|                    |                     | Single              | Multiple | Bone                    | Shaft               | Metaphysis          | Epiphysis          | Medullary               | Periosteal               | Osteolytic              | Osteo-plastic            |
| 0-20               | 21-70               | Exostoses           | ...      | Lo. femur, up. tibia    | Exostoses           | Exostoses           | ...                | ...                     | Exostoses                | ...                     | Exostoses                |
| Periosteal sarcoma | ...                 | Periosteal sarcoma  | ...      | Lo. femur, up. tibia    | ...                 | Periosteal sarcoma  | ...                | ...                     | Periosteal sarcoma       | ...                     | Periosteal sarcoma       |
| Ewing's sarcoma    | ...                 | Ewing's sarcoma     | ...      | Tibia, femur            | Ewing's sarcoma     | ...                 | ...                | Ewing's sarcoma (late)  | Ewing's sarcoma (early)  | Ewing's sarcoma (late)  | Ewing's sarcoma (early)  |
| Garré's osteitis   | ...                 | Garré's osteitis    | ...      | Tibia, femur            | Garré's osteitis    | ...                 | ...                | Garré's osteitis (late) | Garré's osteitis (early) | Garré's osteitis (late) | Garré's osteitis (early) |
| Bone cyst          | ...                 | Bone cyst           | ...      | Up. humerus, up. tibia  | Bone cyst           | Bone cyst           | ...                | Bone cyst               | ...                      | Bone cyst               | ...                      |
| Osteolytic sarcoma | ...                 | Osteolytic sarcoma  | ...      | Femur, tibia            | Osteolytic sarcoma  | Osteolytic sarcoma  | Osteolytic sarcoma | Osteolytic sarcoma      | ...                      | Osteolytic sarcoma      | ...                      |
| Brodie's abscess   | ...                 | Brodie's abscess    | ...      | Tibia, femur            | ...                 | Brodie's abscess    | ...                | Brodie's abscess        | ...                      | Brodie's abscess        | ...                      |
| ...                | Myxo-sarcoma        | Myxo-sarcoma        | ...      | Femur, tibia            | ...                 | Myxo-sarcoma        | Myxo-sarcoma       | Myxo-sarcoma            | Myxo-sarcoma             | Myxo-sarcoma            | Myxo-sarcoma             |
| Osteo-myelitis     | ...                 | Osteo-myelitis      | ...      | Up. tibia, lo. femur    | ...                 | Osteo-myelitis      | Osteo-myelitis     | Osteo-myelitis          | Osteo-myelitis           | Osteo-myelitis          | Osteo-myelitis           |
| Tuber-culosis      | ...                 | Tuber-culosis       | ...      | Spine, knee, hip, ankle | ...                 | Tuber-culosis       | Tuber-culosis      | Tuber-culosis           | ...                      | Tuber-culosis           | ...                      |
| ...                | Syphilis            | Syphilis            | ...      | Tibia, skull            | Syphilis            | ...                 | ...                | Syphilis (late)         | Syphilis (early)         | Syphilis (late)         | Syphilis (early)         |
| ...                | Fibro-sarcoma       | Fibro-sarcoma       | ...      | Lo. femur, up. tibia    | Fibro-sarcoma       | ...                 | ...                | ...                     | Fibro-sarcoma            | Fibro-sarcoma           | ...                      |
| ...                | Myositis ossificans | Myositis ossificans | ...      | Thigh, elbow            | Myositis ossificans | Myositis ossificans | ...                | ...                     | Myositis ossificans      | ...                     | Myositis ossificans      |
| ...                | Giant-cell tumor    | Giant-cell tumor    | ...      | Lo. femur, lo. radius   | ...                 | ...                 | Giant-cell tumor   | Giant-cell tumor        | ...                      | Giant-cell tumor        | ...                      |
| ...                | Chondroma           | Chondroma           | ...      | Hands, feet             | Chondroma           | ...                 | ...                | Chondroma               | ...                      | Chondroma               | ...                      |
| ...                | Bone cyst, latent   | Bone cyst, latent   | ...      | Femur, tibia            | Bone cyst, latent   | ...                 | ...                | Bone cyst, latent       | ...                      | Bone cyst, latent       | ...                      |

TABLE II

|                    |                      |                      |                         |                      |                      |                      |                      |
|--------------------|----------------------|----------------------|-------------------------|----------------------|----------------------|----------------------|----------------------|
| ---                | Metastatic carcinoma | Metastatic carcinoma | Spine, pelvis           | Metastatic carcinoma | Metastatic carcinoma | Metastatic carcinoma | Metastatic carcinoma |
| ---                | Multiple myeloma     | Multiple myeloma     | Spine, ribs             | Multiple myeloma     | Multiple myeloma     | Multiple myeloma     | Multiple myeloma     |
| ---                | Osteo-malacia        | Osteo-malacia        | Spine, pelvis           | Osteo-malacia        | Osteo-malacia        | Osteo-malacia        | Osteo-malacia        |
| ---                | Osteitis deformans   | Osteitis deformans   | Skull, tibia            | Osteitis deformans   | Osteitis deformans   | Osteitis deformans   | Osteitis deformans   |
| Multiple exostoses | ---                  | Multiple exostoses   | Forearm, leg            | Multiple exostoses   | Multiple exostoses   | Multiple exostoses   | Multiple exostoses   |
| Marble bones       | ---                  | Marble bones         | Legs, arms              | Marble bones         | Marble bones         | Marble bones         | Marble bones         |
| Fragile bones      | ---                  | Fragile bones        | Long bones              | Fragile bones        | Fragile bones        | Fragile bones        | Fragile bones        |
| Rickets            | ---                  | Rickets              | Ribs, skull, long bones | Rickets              | ---                  | Rickets              | Rickets              |
| Scurvy             | ---                  | Scurvy               | Long bones, jaw         | Scurvy               | Scurvy               | Scurvy               | Scurvy               |

TABLE OF BONE LESIONS IN ORDER OF  
FREQUENCY

|   |            |
|---|------------|
| Metastatic carcinoma.....                           | 300 cases  |
| Periosteal osteogenic sarcoma.....                  | 260 cases  |
| Osteochondroma (exostosis).....                     | 260 cases  |
| Giant-cell tumor.....                               | 230 cases  |
| Bone cysts.....                                     | 170 cases  |
| Osteolytic osteogenic sarcoma.....                  | 100 cases  |
| Garré's sclerosing osteomyelitis <sup>1</sup> ..... | 100 cases  |
| Myxosarcoma.....                                    | 80 cases   |
| Chondromyxoma.....                                  | 70 cases   |
| Ewing's sarcoma.....                                | 65 cases   |
| Periosteal fibrosarcoma.....                        | 40 cases   |
| Latent bone cysts.....                              | 30 cases   |
| Myositis ossificans.....                            | 30 cases   |
| Multiple bone cysts and osteomalacia.....           | 25 cases   |
| Paget's osteitis deformans.....                     | 20 cases   |
| Multiple myeloma.....                               | 20 cases   |
| Brodie's abscess.....                               | 20 cases   |
| Fragile bones.....                                  | 5 cases    |
| <i>Total</i> .....                                  | 1825 cases |

|                     |            |
|---------------------|------------|
| Osteomyelitis ..... | 1312 cases |
| Tuberculosis .....  | 101 cases  |
| Syphilis .....      | 30 cases   |

<sup>1</sup>Including ossifying periostitis.

## PART A

## NEOPLASTIC ENTITIES OF BONE OCCURRING AS SOLITARY LESIONS

Most of the lesions which the diagnostician is called upon to differentiate in the roentgenogram occur as a single area of involvement in one of the long pipe bones. If multiple involvement of the skeleton occurs, with changes in the pelvis, spine, and skull, the possibilities are at once limited to a more restricted group, and the problem of differential diagnosis greatly simplified. Because of this direct bearing upon the diagnosis, the solitary or multiple nature of the bone involvement has been used as the primary basis of classification in grouping the tumors studied from the standpoint of X-ray diagnosis. The various types of single lesions of bone are discussed first under the following sectional headings: I. Osteoplastic Lesions Prevalent in Patients under Twenty; II. Osteolytic Lesions Prevalent in Patients under Twenty; III. Tuberculosis, Syphilis, Osteomyelitis, and Myxosarcoma; IV. Ossifying Periosteal Lesions Prevalent

in Adults; V. Osteolytic Lesions Prevalent in Adults.

### *I. Osteoplastic Lesions Prevalent in Patients under Twenty*

This group of lesions which comprises the

the tumor is in reality an outgrowth of normal cortical and cancellous bone through a congenital periosteal defect. In the periosteal osteogenic sarcomas, two separate kinds of ossification occur, dependent upon the histologic variety of the tumor. In the osteo-



Fig 4. Roentgenogram of a typical benign exostosis of the upper tibia. The normal bone bulges out to meet the neoplastic cartilaginous cap and forms a base or pedicle for the growth. Lines of calcification are present in the cartilaginous portion.\*

Photography by Mr Herman Schapiro.

benign exostoses, periosteal osteogenic sarcomas, Ewing's sarcoma, and Garré's sclerosing osteomyelitis, includes the most frequent forms of bone tumor—the exostoses and osteogenic sarcomas together forming by far the largest group. Although all four of these clinical entities may be designated as periosteal bone-forming lesions in accordance with conventional terminology, yet the exact mode and site of ossification varies widely within this group. In the exostoses or osteochondromas, the bone formation in

blastic osteogenic sarcoma, tumor bone originates in the subperiosteal zone and rapidly permeates the haversian system of the cortex, gaining entrance to the medullary cavity. In the chondral form of osteogenic sarcoma, the tumor gives rise to calcification and not primary bone, the small spicules of bone which may be present usually occurring as a reaction in the raised periosteum. In Ewing's sarcoma and in Garré's sclerosing osteomyelitis, bone formation is entirely secondary in its occurrence, and is stimulated

in the endosteum, cortex, and periosteum by invasion of the lymphatics—by tumor cells in the former instance, and by a low grade infection in the latter.

1. *Exostoses or osteochondromas*.—The osteochondromas or exostoses are benign

upper tibia about the knee, the lower tibia and os calcis about the ankle, the upper humerus at the shoulder, and the greater trochanter of the femur at the hip (Fig. 3). While a definite number of the osteochondromas escape clinical observation because



Fig 5 Photomicrograph showing the three zones of tissue characteristic of a benign exostosis or osteochondroma. In the upper part of the section there is connective tissue continuous with the tendon. Beneath this there is cartilage, showing fetal cartilage, adult cartilage, and calcifying chondral tissue. Beneath the cartilage is cancellous bone enclosing marrow tissue.

tumors, usually occurring between the ages of ten and twenty-five years (Fig. 2) near the metaphyseal ends of the long bones and forming bony skeletal outgrowths with a thin cartilaginous cap. The symptoms in persons thus affected are generally mild and of long duration, averaging over five years in the cases of the present series. Males are affected approximately one and one-half times as often as females, and in 90 per cent of the patients there is but a single area of bone involvement. The distribution in the skeleton of these periosteal bone formative tumors is, in the order of frequency of the region affected, the lower femur and

of the absence of symptoms, the majority give evidence of their presence by painless swelling of the bone or by stiffness, with rheumatic aches in the neighboring joint.

In the roentgenogram the configuration of the tumor is readily analyzed into two separate portions, a base or pedicle of normal bone and a cartilaginous cap of neoplastic tissue (Fig. 4). The slow growth of the tumor is portrayed in the roentgenogram by the differentiation of the base or pedicle into zones of normal cancellous and compact bone and by calcification in the overlying cartilaginous cap. The morphology of the osseous portion of the tumor varies

from a narrow elongated pedicle to that of a broad flattened base or platform. The cartilaginous cap may be insignificant and nearly invisible or may overgrow the rest of the tumor with a large cauliflower mass.

formation of the attachment by cartilaginous ossification within the substance of the tendon. The exostosis or osteochondroma represents a failure accurately to approximate the juncture of these different tissues. As

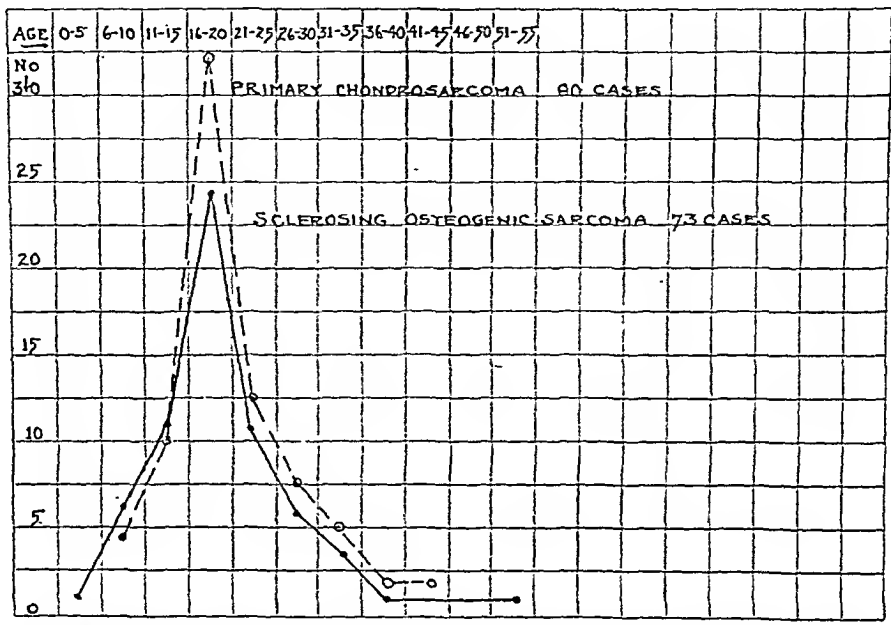


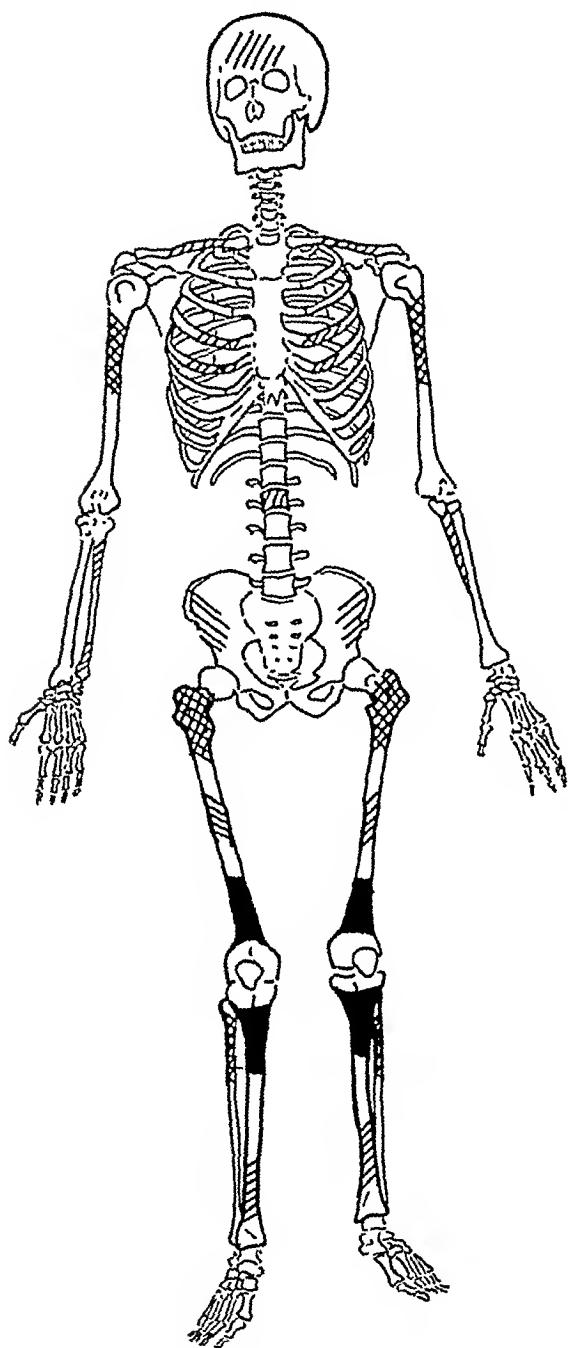
Fig. 6. Chart showing the age incidence of periosteal osteogenic sarcoma. The solid line indicates sclerosing osteogenic sarcoma derived from osteoblasts and the broken line indicates the cases of primary chondrosarcoma.

An overlying bursa containing fluid or calcified material may be definitely visible in the X-ray film. Pathologic fracture is extremely rare, occurring in approximately 1 per cent of the cases, and always takes place through the pedicle of the lesion rather than through the shaft of the underlying bone.

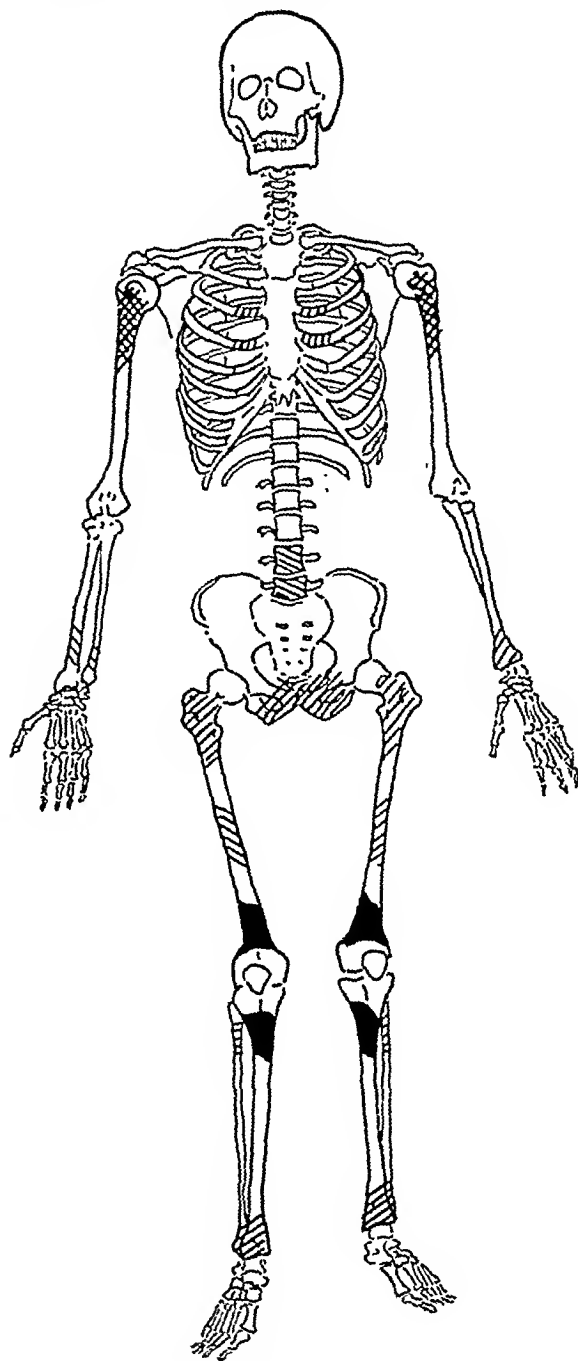
The histogenesis of these lesions is valuable in interpreting the X-ray findings. These neoplasms occur at the site of a congenital defect in the periosteum, the defect arising at a point in the bone predestined for some important tendinous insertion, such as the quadriceps femoris, the adductor magnus, or the Achilles tendon. At this junction Nature provides for a normal protuberance of bone, which bulges through a normal gap in the periosteum to meet an adjoining tendon, which co-operates in the

a result the normal bone protrudes excessively through the widened periosteal gap, forming the base or pedicle of the exostosis, and the cartilaginous center of ossification in the tendon reduplicates in excess, forming the large cauliflower cap typical of the osteochondromas or exostoses. This mode of origin is not only traceable in the roentgenograms, but is also borne out microscopically (Fig. 5). The significance of this histogenic analysis for roentgen-ray diagnosis lies in the fact that the bulging of the normal underlying bone through a periosteal gap to form a base or pedicle always points to the existence of an exostosis or osteochondroma, regardless of the size or form of the cartilaginous cap and whether or not secondary changes therein have occurred (1. 2).

## SCLEROSING OSTEOGENIC SARCOMA



## PRIMARY CHONDROSARCOMA



Figs. 7-A and 7-B. Figure 7-A shows the incidence of sclerosing osteogenic sarcoma according to skeletal location, and Figure 7-B, the incidence of primary chondrosarcoma. The solid black areas indicate the most frequent sites; the checked areas, the common sites, and the diagonal line areas, the occasional sites.

While a favorable prognosis may be given all cases with typical exostoses and surgical intervention is not warranted in patients

with mild or no symptoms, yet recurrences may follow incomplete excision or failure to approximate the soft parts over the peri-



Fig. 8 (left). Roentgenogram showing a typical sclerosing osteogenic sarcoma, with dense shaggy new bone formation beneath the periosteum in the metaphyseal region, and sclerosis of the marrow cavity.

Fig. 9 (right). Typical roentgenogram of a primary chondrosarcoma, showing the translucent periosteal shadow and the delicate lines of calcification next to the bone. The cortex and medulla of the bone are not involved.

osteal gap. Secondary malignant change occurs in a definite percentage of these tumors, resulting in a slow growing chondromyxosarcoma. This malignant change, however, always gives warning of its occurrence by rapid increase in the size of the tumor, increased severity of the symptoms, and lytic changes in both the chondral and osseous portions of the neoplasm. These secondary malignant growths are discussed subsequently under Myxosarcoma (*which see*).

2. *Periosteal osteogenic sarcoma*.—Periosteal osteogenic sarcoma, which results fatally in between 70 and 90 per cent of all cases, is the most frequent form of primary

bone tumor. Among patients with this disease, males outnumber females in proportion of nearly two to one, and patients in the decade between ten and twenty years are affected approximately four times as often as in any other decade (Fig. 6).

Osteogenic sarcoma is practically never a multiple lesion in bone and in only the rarest instances does it metastasize to other bones. The usual form shows a periosteal zone of new bone formation classically at right-angles to the cortex. This new bone formation may be very delicate or very shaggy. It may produce sclerosis in the underlying cortex and marrow cavity, with some bone destruction, or it may not in-

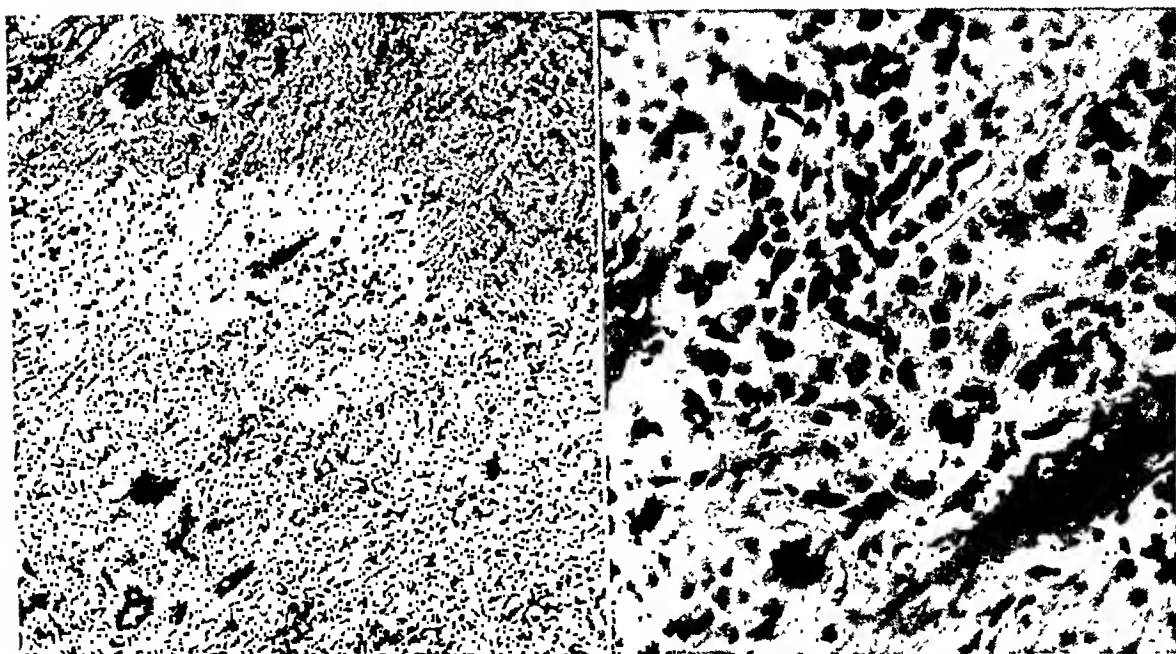


Fig. 10. Low and high power photomicrographs of sclerosing osteogenic sarcoma. The tumor is composed of malignant osteoblasts derived from fibroblasts. There is an irregular formation of osteoid spicules.

involve these cortical and medullary regions. Such variation is not due to an inconsistency in the nature of the tumor, but, rather, to an error in histogenic analysis, because the usual tumor referred to as a periosteal osteogenic sarcoma is not a single entity but in reality comprises two types of sarcoma, a true periosteal chondrosarcoma and a more diffuse subperiosteal osteoblastic sarcoma. These two types are approximately equal in frequency of occurrence. They both involve most frequently the metaphyseal regions of the lower femur and the upper tibia about the knee, but nevertheless they can be definitely distinguished both in the X-ray film and under the microscope. The importance of differentiating between these two forms of periosteal osteogenic sarcoma lies in the difference in prognosis; the osteoblastic form is curable by amputation in about 30 per cent of the cases, whereas the chondrosarcoma offers less than 10 per cent of chances of eradication, by even the most radical form of therapy.

Both the osteoblastic and chondral forms of osteogenic sarcoma give similar symptoms of rapidly increasing pain and swelling followed by a dysfunction of the affected limb. The chondrosarcoma shows its more malignant nature by the briefer duration of symptoms, the average being under six months in this group, while that of the osteoblastic form averages ten months. Pathologic fracture practically never occurs in either form of growth.

On the X-ray film the osteoblastic form of osteogenic sarcoma shows very shaggy and heavy lines of radiating new bone formation projecting in the periosteal region. This dense newgrowth is not confined, however, to the periosteal zone, but invades the marrow cavity, producing mottling and sclerosis (Figs. 7-A and 7-B). In a series of nearly a hundred cases the region of involvement is practically without exception metaphyseal, the epiphysis being occasionally involved secondarily by extension in its medullary portion. The borders of the in-



volved area are exceedingly irregular. In most cases the earliest signs of the new-growth are spicules of new bone emanating at right-angles from the cortex in the periosteal zone. In some cases, however, the

Roentgenologic evidence of the presence of the chondral form of osteogenic sarcoma is never as pronounced in the X-ray film as the osteoblastic form, because most of the cartilaginous substance of the tumor is



Fig. 11. Photomicrograph of a primary chondrosarcoma. There is a proliferation of small embryonic connective tissue cells in the lower portion of the picture, from which fetal and adult cartilage are developing. In the upper portion of the picture, there is calcification of cartilage and new bone formation. This tumor, therefore, is repeating the entire histogenesis of bone, showing the transition from connective tissue to cartilage and calcified cartilage to bone. The section is taken from a metastatic lung nodule, and thus new bone of the reactive type can be excluded.

pattern of bone formation is less distinct, while in others the only evidence of the tumor is the dense sclerosed area visible in the medullary region, with very little hazing in the periosteal zone. So-called lipping of the periosteum, characterized by the triangular area of elevation with a thin marking of new bone at the outer margin, is frequently seen on the side of the tumor area toward the mid-shaft.

highly translucent or invisible in the film. Three important features combine to give the typical X-ray picture of ossifying chondrosarcoma a characteristic appearance: the faintly visible, semi-translucent soft-part shadow next the bone, the raising of the neighboring periosteum in more or less parallel layers, and the frequent absence of cortical or medullary bone involvement. The bulk of the tumor is extra-cortical, and

whether anterior or lateral views be taken, only a single border of the bone is usually involved. The region affected is most frequently one of four favorite sites: the medial side of the lower femur at the adductor

ways presents an indefinite and infiltrating edge at its apex. Most of the extra-cortical tumor mass extends under the periosteum, working its way along the shaft, but the point of maximum growth is not encapsu-

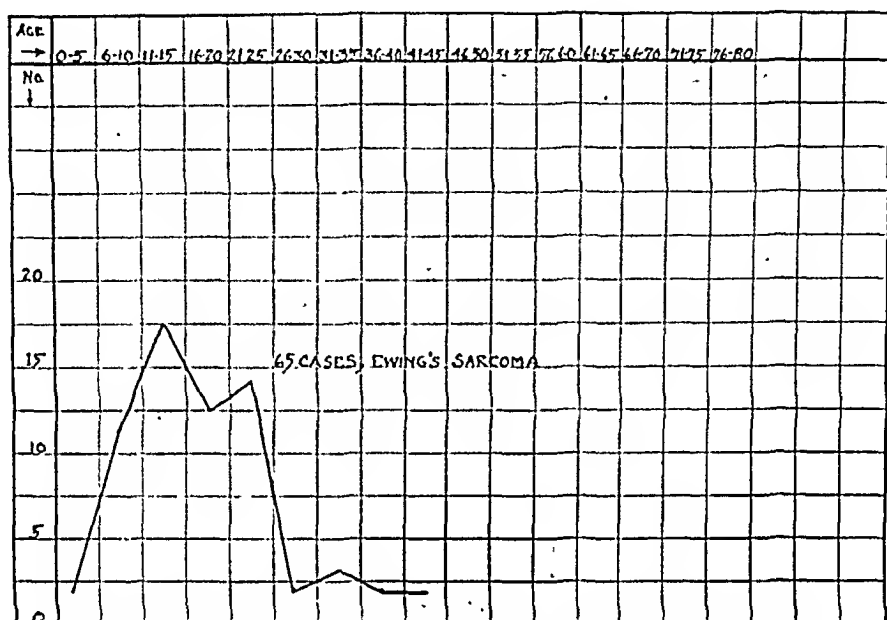


Fig. 12. Chart showing the age incidence of Ewing's sarcoma.

tubercle, the inner aspect of the tibial tuberosity, the margins of the pelvis, or about the greater tuberosity of the humerus. When new bone of tumor origin is present the formation is always sparse, and takes the form of finely radiating lines at the base of the tumor shadow next the bone. Lines of calcification may interlace among the soft-part shadow to give it a loose, soap-bubble effect (Figs. 8 and 9).

Much diagnostic help is gained by comparing the inner margin of the tumor which borders on cortical bone with the peripheral portion extending into the soft parts. The inner margin is most often formed by smooth and normal cortex, although rarely, in later stages, the layers of the cortex may be split and invaded by tumor which finds its way into the marrow cavity. Outwardly, on the other hand, the tumor al-

lated by this structure. The absence of periosteum at this point is explained by the normal anatomical peculiarities of the tumor site, for at these points there is to be found a direct union of tendon to bone without an intervening periosteum.

The basis for the clinical and roentgenologic difference between these two forms of periosteal sarcoma is fundamentally grounded in the separate histogenesis of the two tumors (Figs. 10 and 11). The chondrosarcoma, often referred to as chondromyxosarcoma, arises in an embryonal form of periosteal connective tissue, known to embryologists as the extra-skeletal blastema and to pathologists as myxoma. This extra-skeletal tissue in the embryo forms joints and peri-articular structures, including the bony ends of the tendons and ligaments, particularly the ends of tendons

## EWING'S SARCOMA

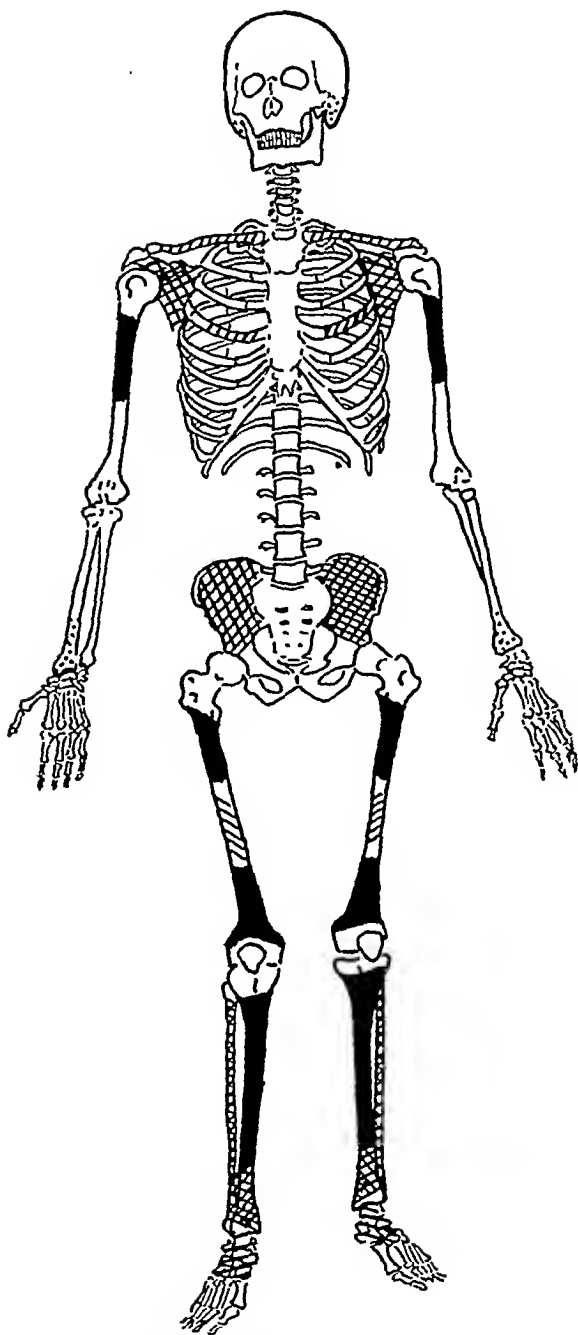


Fig. 13. Chart showing the incidence of Ewing's tumor according to skeletal location. The solid black areas indicate the most frequent sites; the checked areas, the common sites; the diagonal line areas, the occasional sites, and the dotted areas, the rare sites.

uniting directly to bone such as the quadriceps tendon, adductor magnus, Achilles, etc. It is in reality a pre-cartilaginous tissue, although in the region of the joints it

can undergo regressive changes, producing synovial spaces, such as the joints and bursæ. The site of origin of chondrosarcoma, therefore, is either truly periosteal or extra-skeletal, and these tumors may arise some distance from the bone in a cartilaginous center of a tendon (2). Histogenetically, these tumors are closely related to the osteochondromas, a point which will be emphasized farther under the heading of Myxosarcoma (*which see*). The bulk of the tumor is either precartilaginous (myxomatous) or cartilaginous and therefore translucent or nearly invisible in the X-ray film. Only by invasion of the underlying cortex of the bone does this tumor stimulate a small amount of new bone reaction, or, when invading the bone marrow, produce medullary bone destruction.

The osteoblastic form of osteogenic sarcoma, on the other hand, arises in the subperiosteal osteogenic layers of the bone, from the primitive layers of periosteum next the cortex which are capable of direct membranous bone formation. This osteogenic layer of the periosteum ceases at the epiphyseal line in patients over three and one-half years of age, and also decreases steadily in proliferative powers after birth at the mid-shaft region, where ossification is complete early in life. This accounts for the predominant metaphyseal site of these growths. Since the tissue of origin and the area involved are primarily osteogenic in nature, the result on the X-ray film as well as microscopically is a tumor predominated by new bone formation. The bone-forming cells of the tumor readily permeate the haversian canals, producing the sclerosing of the marrow cavity so important from the standpoint of X-ray diagnosis.

If the histogenic distinction between these two forms of periosteal osteogenic sarcoma is borne in mind, the differentiation may be made between them in the roentgenogram. The chondral form is char-



Fig. 14. The typical roentgenologic appearance of Ewing's sarcoma. There is expansion of the shaft of the bone, produced by thickening of the cortex which is reacting to tumor invasion. This is an early stage of the disease.



Fig. 15. In the uniformity in the size of the cells in the sarcoma. In the less compact regions the cytoplasm has a definite but irregular outline. There is a typical fibrous strand traversing the cellular areas.

acterized by the translucency of the tumor mass, which is restricted to the periosteal zone, producing cortical and medullary destruction only in the late stages; while the periosteal form is characterized by diffuse dense and shaggy new bone formation, greatest in the periosteal region, but also producing medullary sclerosis early in the disease.

The opportunities for complete cure are not great in even the earliest stages of either type of periosteal osteogenic sarcoma. Deep X-ray therapy may limit local extension of the tumor, but metastases are not inhibited nor is lysis stimulated in the tumor mass. Early amputation when the growth is below the ankle or in the tibia or femur and resection when the fibula or humerus is affected, offers nearly 30 per cent of chances of a cure in the osteoblastic form and about 10 per cent in the chondral form. In this chondral form of sarcoma, radium implantation into the operative wound should be tried, as there is some evidence that this is more effective than X-ray therapy (3, 4).

3. *Ewing's sarcoma*.—This third type of malignant tumor of the bone is about one-fourth as frequent in occurrence as the periosteal osteogenic sarcomas. It is essentially a disease of early life, 95 per cent of the tumors occurring in the first two decades. Males predominate over females in an approximate ratio of two to one. In the early stages the tumor is always single, but the growth may metastasize to other bones in about one-fourth of the cases. The bones most frequently involved are those of the long pipe class, the tibia and femur leading the list, although the ilium, scapula, clavicle, skull, and bones of the feet are occasionally affected. In the present series of sixty-five cases, in no instance was the primary location of the tumor on other than the shaft side of the bone. Pathologic fracture is of relatively rare occurrence in Ewing's sarcoma—it was noted in only three cases in the series, all of these in the femur, a weight-bearing bone (Figs. 12 and 13).

Either pain or tumor may be the initial symptom in these cases, but both are present in the later stages. The average duration of

symptoms is thirteen and one-half months at the time of clinical observation. Mild fever, leukocytosis of about 15,000 white cells, and enlargement of the regional lymph nodes in about one-third of the cases lead to an erroneous diagnosis of acute osteomyelitis.

mation" is helpful in making the diagnosis from the X-ray film, but this is usually visible only in the early cases. In the late cases metastasis to other bones, particularly the skull, is one of the striking characteristics of this disease.

The histogenesis of these tumors is valu-

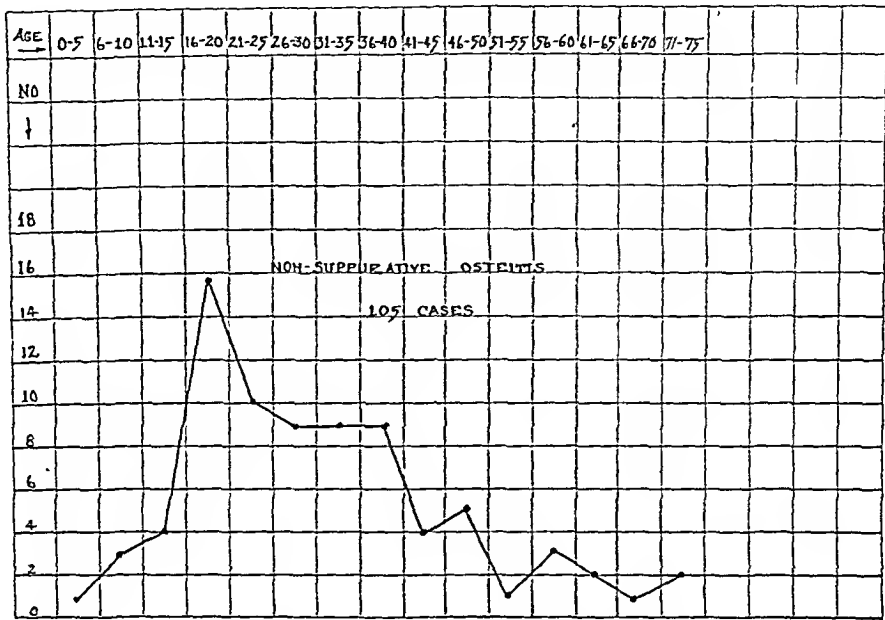


Fig. 16. Chart showing the age incidence of Garre's non-suppurative osteitis.

The first sign of the Ewing tumor in the roentgenogram is a fusiform widening of the shaft, due to parallel layers of subperiosteal new bone formation. Widening of the cortex occurs at this point, with narrowing and even obliteration of the marrow cavity. The current conception that Ewing's sarcoma is a central bone-destructive lesion is erroneous. The site of origin of the growth is subperiosteal and intracortical in the lymphatic channels of the bone, which leads to an early reaction of new bone formation in both the endosteal and periosteal zones. Later in the disease extensive stripping of the periosteum may lead to right-angle new bone formation, while pronounced invasion of the marrow cavity leads to areas of bone destruction (Fig. 14). Splitting of layers of the cortex into the so-called "onion-peel for-

able in the analysis of the X-ray film. The tumor arises in all probability about the lymphatics of bone in the subperiosteal regions and in the haversian canals (Fig. 15). This mode of origin accounts for both the manner in which the tumor spreads and the early stimulation of reactive new bone. The growth extends beneath the periosteum, giving an elliptical area of involvement, and permeates the haversian spaces, stimulating the cortical bone to reaction. At the age and the site of tumor involvement, bone formation is very active, and hence the widening of the shaft so characteristic in the X-ray film.

The Ewing's sarcoma is definitely radio-sensitive and permits, therefore, a therapeutic test in making the diagnosis. Although the best results are generally ob-

tained by radical resection or amputation plus irradiation, some five-year cures have been established by irradiation alone. Proper treatment offers slightly over 10 per cent of chances of cure in this group of tumors (5, 6).

4. *Garré's sclerosing osteitis*.—Because of a similarity in the roentgenogram to Ewing's sarcoma a summary is included here of Garré's sclerosing osteitis. This condition runs a benign protracted course and in the typical form is much rarer than Ewing's sarcoma. In German clinics it has been estimated that less than 5 per cent of all osteomyelitis is of the Garré type, a conclusion that is borne out by the statistics in this laboratory.<sup>2</sup> The age incidence and the site of bone involvement parallel closely the Ewing's sarcoma, as will be seen in the charts (Figs. 16 and 17). Practically all of the cases occur before the age of twenty-five. The lesion is solitary in character and most frequently affects the tibia, which is involved in slightly over half of the cases. The clinical course of Garré's osteitis, however, is the reverse of that in Ewing's tumor. Whereas in Ewing's sarcoma the disease begins mildly, but rapidly produces acute symptoms within the space of a few months, in sclerosing osteitis there is often an acute onset, with fever and leukocytosis, which rapidly subsides into a chronic course extending over a period of not months but years. The pain is not severe but may be aggravated by exertion and is often worse at nights. Some previous systemic infection such as pneumonia, influenza, or typhoid may be recorded in the history.

In the roentgenogram the area of tumefaction may closely resemble the early stages of Ewing's sarcoma. A fusiform widening of the shaft is produced in the affected region by the stimulation of new bone formation in the periosteal and cortical zones

## NON-SUPPURATIVE OSTEITIS

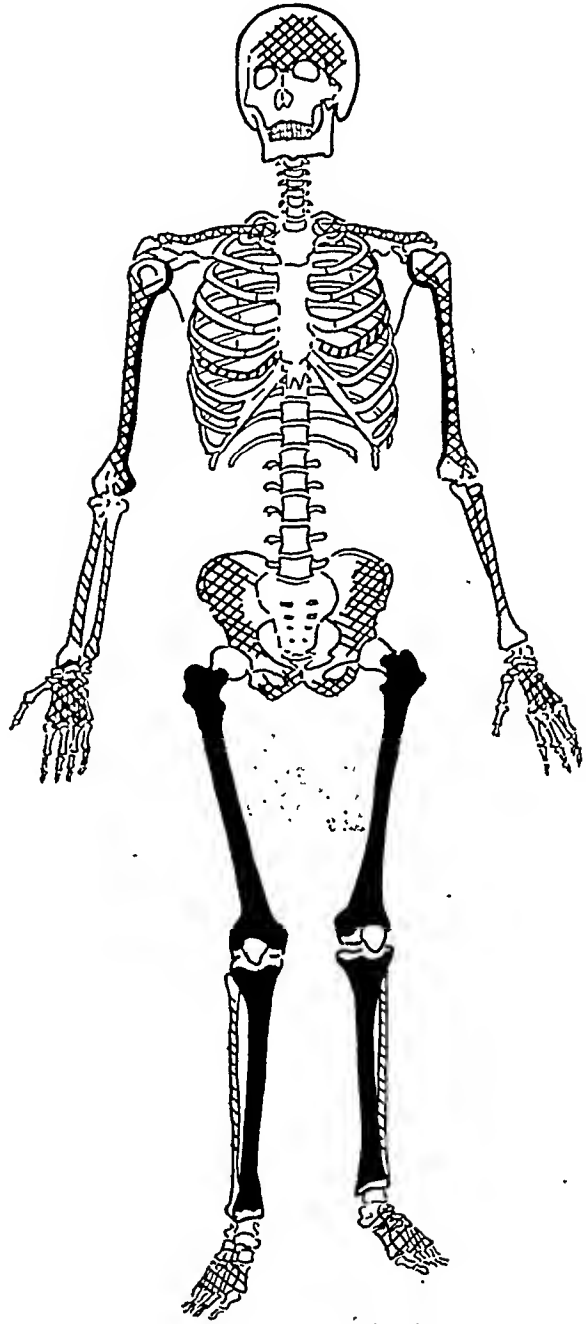


Fig. 17. Chart showing the incidence of Garré's non-suppurative osteitis according to skeletal location. The solid black areas indicate the most frequent sites; the checked areas, the common sites, and the diagonal line areas, the occasional sites.

(Fig. 18). As a result of this reaction, the medullary cavity is narrowed or obliterated, while the cortex is thickened and its density much increased. Ossification is more pro-

<sup>2</sup>Trendel: Beitr. z. klin. Chir., 1903-04, XLI, 607.



Fig. 18. Roentgenogram of the lower tibia of a patient with Garre's osteitis. There is a diffuse ossifying lesion of the shaft with sclerosis of cortical and cancellous bone and roughening of the periosteum. Note the spindle-shaped swelling produced by the widening of the shaft.

nounced than in a Ewing's sarcoma and the "onion-peel formation" in the periosteum, typical of the Ewing's tumor, is lacking.

The pathology of Garre's osteitis explains its close similarity in the roentgenogram to the early Ewing's tumor. Sclerosing osteitis is the result of a low-grade infection in the lymphatics of the bone (Fig. 19), which brings about an increased fibrous and fibro-osseous proliferation, resulting in thickening of the periosteum and diminishing vascularity in the regions affected. As in the Ewing tumor, the lymphatic involvement coincides in location with the locus of osteogenic tissue, which is particularly active at



Fig. 19. Photomicrograph showing new bone formation in granulation tissue, illustrating the typical pathologic changes seen in Garre's non-suppurating osteitis.

the age period when these lesions occur. New bone formation in the endosteal and periosteal layers of the bone is thus secondary to the neighboring lymphatic invasion.

The prognosis in Garre's osteitis is always favorable for life, although the treatment is not uniformly satisfactory. Drainage into the cortical area of the bone by multiple drill holes or by the chiselling of a groove, stimulates vascularity and may result in cure. Diathermy or the application of heat by other methods without surgical intervention may be equally effective, but a definite percentage of the cases are refractory to any method of treatment. Deep X-ray therapy should be tried first in these cases (7, 8).

*Summary of solitary osteoplastic lesions in patients under twenty.*—Four lesions have been grouped under the solitary ossifying tumors occurring in patients under twenty. These are the exostosis, periosteal osteogenic sarcoma, Ewing's sarcoma, and Garre's osteomyelitis. The most common of these lesions are benign exostosis and the malig-

nant osteogenic sarcoma. Ewing's sarcoma is relatively rare and Garré's sclerosing osteomyelitis still rarer. Exostosis and osteogenic sarcoma are usually localized growths concentrated at a single point in the

tic form of osteogenic sarcoma produces from the first sclerosing and mottling in the marrow cavity. In Ewing's sarcoma, the medullary cavity is narrowed and later perforated by bone destruction. In Garré's os-

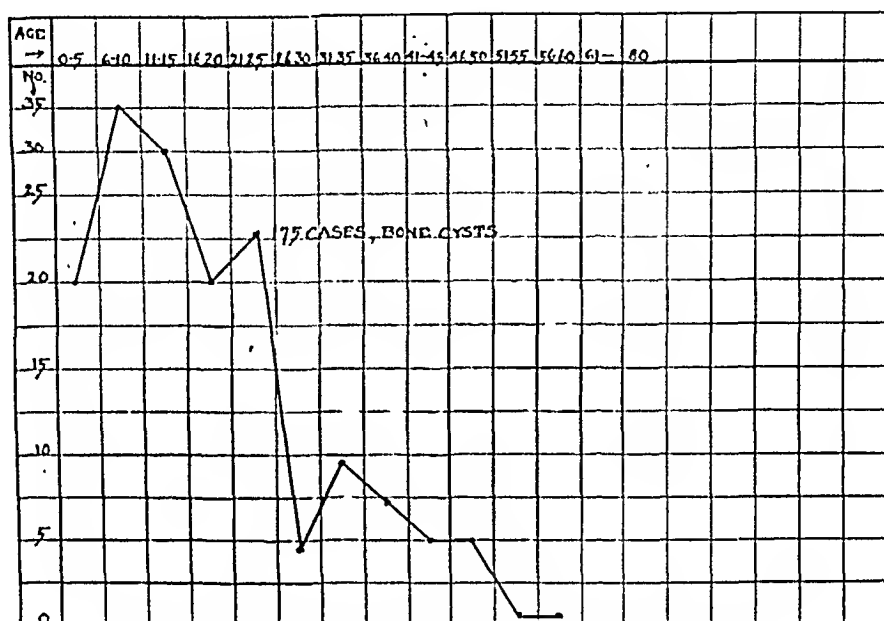


Fig. 20. Chart showing the incidence of benign bone cysts.

periosteal zone. The new bone formation projects at right-angles to the shaft—in the exostosis in the form of an orderly organized pedicle or base of normal bone, in osteogenic sarcoma in a disorderly fashion of radiating spicules of tumor bone. The new bone formation in Ewing's sarcoma and Garré's osteomyelitis extends in a parallel fashion along nearly one-half of the extent of the shaft. There is thus produced a diffuse fusiform widening of the shaft at the site of the involvement, due to periosteal bone formation, while endosteal bone formation in the same region thickens the cortex inwardly, tending to obliterate the marrow cavity. The medullary cavity is practically never involved by an exostosis. The chondral form of osteogenic sarcoma rarely disturbs it except with areas of bone destruction late in the disease. The osteoblas-

teomyelitis the medullary cavity is narrowed or obscured by cortical bone formation, but medullary bone destruction rarely occurs. Pathologic fracture is not frequent in any of these lesions.

## II.—Solitary Osteolytic Tumors Prevalent in Patients under Twenty

In young patients a single bone-destructive lesion is usually medullary in character. Both benign and malignant tumors of this type occur, but by far the most frequent is the benign solitary bone cyst. In rare instances the bone cyst may be simulated by a focus of infection in the medullary cavity, the Brodie's abscess. Osteolytic sarcoma of the bone may also resemble the bone cyst, but most frequently produces far more destruction in all of the bone layers. These three groups of lesions, the bone cyst, osteo-



## BONE CYSTS

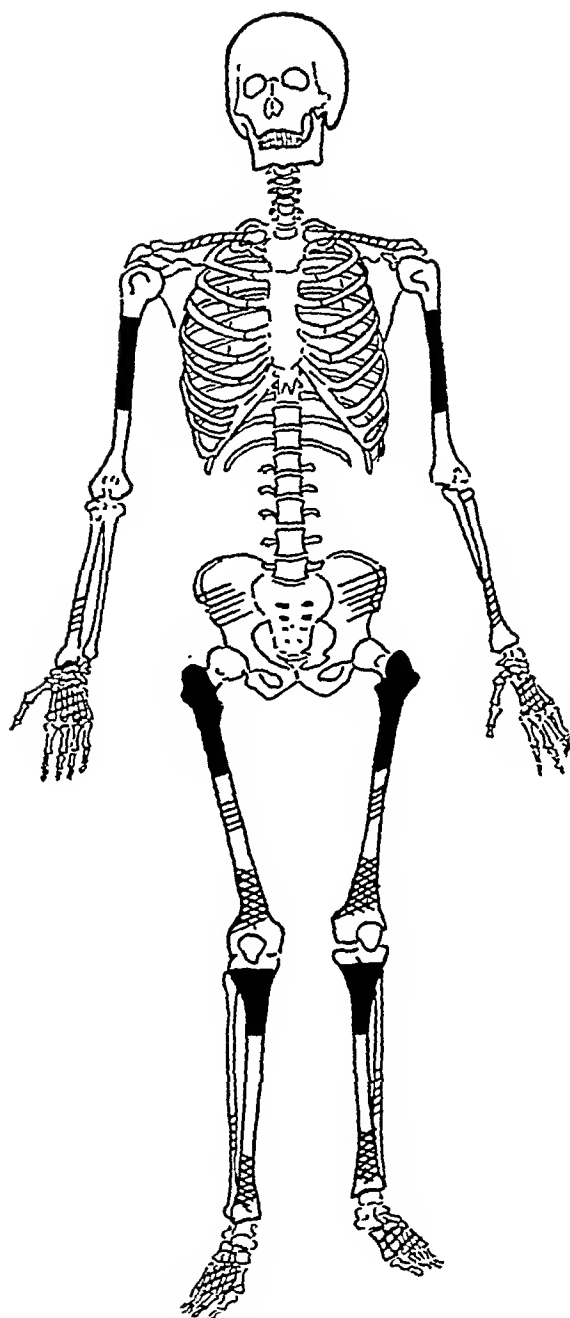


Fig. 21. Chart showing the incidence of bone cysts according to skeletal location. The solid black areas indicate the most frequent sites; the checked areas, the common sites, and the diagonal line areas, the occasional sites.

lytic sarcoma, and Brodie's abscess will be considered separately.

1. *Bone cyst*.—The solitary bone cyst is a form of osteitis fibrosa found usually in

the metaphyseal region of the shafts of the long bones of young patients. The average age is between ten and fifteen years and the usual location is the upper humerus, upper tibia, or upper femur (Figs. 20 and 21). The patient often comes under observation because of trauma, with pathologic fracture, the symptoms of the disease in other cases being very mild, with slight or no pain. The disease runs a benign and chronic course, the duration of symptoms at the time of clinical observation averaging two and one-half years. In about one-sixth of the cases the tumor persists unobserved for over five years, and when it is discovered it has migrated toward the mid-shaft region, due to the growth of the bone. This group constitutes the so-called latent bone cysts which may occur in patients of any age and is discussed separately in a subsequent section.

X-ray examination of these tumors reveals an ununited epiphysis near the diseased area, the metaphyseal location of the lesion, and a central area of bone destruction casting little or no shadow. About the area of bone destruction the cortex is thin and expanded to form a symmetrical and fusiform swelling. In cases in which pathologic fracture has occurred the margins of the fracture show new bone formation, casting a dense shadow. Such a fracture tends to heal, and in the process of healing the lesion frequently ossifies and disappears. The bone shell about the cyst is rarely perforated except by fracture (Fig. 22). The cystic area of the tumor may be crossed by lines of trabeculation, and the shaft of the bone may be bent or otherwise distorted in the affected region.

At the age and in the location in which the tumors occur there is a relationship to an unossified epiphyseal line. The bone involved is, therefore, an area of bone newly derived from cartilage in a metaphyseal region, and the pathologic process is related to this new bone formation. In a histologic

study such a relationship can be definitely traced (Figs. 23 and 24). Early bone cysts always show areas of giant-cell tissue and this tissue is the cause of the bone destruction which produces the cyst. These giant cells normally play an active rôle in resorbing calcified cartilage in the transition from cartilage to new bone which occurs in the metaphyseal region. Cyst formation is the result of a pathologic overactivity on the part of these giant cells, due to trauma or some metabolic disturbance. By the time most of these lesions come under observation or come to operation, the bone destructive phase has ceased and a second process of new bone formation about the periphery of the tumor, due to the proliferative powers of the neighboring cortex and the subperiosteal osteogenic layers, has occurred, which succeeds in walling-in the diseased area, and may, when pathologic fracture has occurred, entirely heal the area. The prognosis is uniformly favorable in these tumors and cure can be effected by the curetting and crushing of the cavity, or often by X-ray therapy (9, 10).

2. *Osteogenic sarcoma of the osteolytic type.*—Two relatively rare forms of osteogenic sarcoma are prone to produce bone destruction in the medullary region of the long bones: the more frequent of the two is a fibro-osseous form of tumor; the rarer is cartilaginous in nature. The fibro-osseous type of osteolytic sarcoma constitutes about 20 per cent of sarcoma of bone, while the cartilaginous form comprises approximately 5 per cent. In both forms, males predominate over females and the age incidence is maximal between the ages of ten and twenty, as is usual for all sarcomas of bone (Fig 25). In the fibro-osseous form of osteolytic sarcoma, however, there is a larger percentage of cases occurring after the age of thirty (approximately 33 per cent). Despite the fact that both of these sarcomas of bone are medullary and bone-destructive,



Fig. 22 A typical bone cyst in the upper end of the humerus showing ossification and healing after fracture. The following characteristics are illustrated: The cyst is on the shaft side of an unossified epiphyseal line, the cortex about the cyst is thinned and symmetrically expanded, and there is ossification after fracture

their fundamental histologic difference is reflected in both the clinical and X-ray pictures.

The fibro-osseous form of osteolytic sarcoma has a distribution which involves the shaft of the bone towards its middle or in its metaphyseal region. The upper tibia, lower femur, and upper humerus are most frequently affected (Figs. 26-A and 26-B). The average duration of the symptoms is ten months, and pain, tumor, and pathologic fracture are outstanding features, pathologic fracture occurring in 35 per cent of the cases. In the X-ray film the area of bone involvement shows a worm-eaten area of medullary bone destruction without any defi-

nitely circumscribed margin and without new bone formation. The cortex of the bone is rapidly broken through without expansion, a point which differentiates these lesions from the benign bone cysts (Fig.

in this form of sarcoma of bone is not so bad as in the chondral forms. In the series of eighty-seven cases in this group, sixty-three have been followed over five years since treatment, and seven (or 11 per cent)



Fig. 23. Photomicrograph showing a newly formed cyst containing red blood cells and surrounded by a sprinkling of giant cells. This is the early stage of osteitis fibrosa. Compare with Figure 24.

7). The configuration of the lesions may resemble metastatic carcinoma to bone, but in this form of sarcoma the patient is usually younger and the tumor area, which begins subcortically, breaks through the cortex before it assumes the truly central medullary location typical of metastatic carcinoma. The transition between destroyed bone and healthy bone is apt to be more abrupt in this sarcoma than in metastatic carcinoma.

Histogenically these tumors arise from fibrous tissue capable of direct bone formation embedded in the medullary cavity (Fig. 28). Bone formation, which in this tissue is dependent upon previous calcifying of cartilage, does not occur, because such cartilage is lacking at the age when and the site where these tumors arise. The prognosis

are living. The earliest and most radical operative treatment gives the best results.

The chondroblastic form of osteolytic sarcoma usually involves the upper tibia, upper humerus, and lower femur. It produces an area of bone destruction which borders directly on the epiphyseal line, in patients practically always between the ages of fourteen and twenty. The average duration of symptoms is exceedingly brief, being under four months, and the post-operative duration of life rarely exceeds twenty months. Pain and swelling are present in an acute form, but pathologic fracture is not frequent.

In the X-ray film the typical picture of the chondral form of osteolytic sarcoma of bone is a circumscribed or diffuse area of medullary bone destruction occurring on either

side of the epiphyseal line. The cortex and the periosteal zone show a more variable involvement. In advanced stages, when the medullary destruction resembles that seen in Figure 29, the cortex may be expanded and thinned as in a typical giant-cell tumor, the location in the epiphysis making the similarity even greater. However, there is usually periosteal elevation, with an underlying translucent shadow, which distinguishes these tumors from benign giant-cell tumors and makes them more comparable to the advanced stage of the periosteal chondrosarcoma described previously. While this is a separate form of osteogenic sarcoma which histologically can be shown to arise from the proliferating cartilage cells at the epiphyseal line, during the adolescent growth period (Fig. 30), and while the mode of growth is distinct—producing, first, medullary bone destruction near or in the epiphysis, and later cortical or periosteal involvement—still the X-ray picture at the time of clinical examination may be indistinctive and cannot, as a general rule, be distinguished with any degree of accuracy from other forms of osteogenic sarcoma. The usual mistake of diagnosing this as a benign giant-cell tumor can be avoided, however, if one notes that the tumor involves usually both the epiphysis and the metaphysis and produces a definite periosteal lipping.

This is one of the most malignant tumors of the osteogenic sarcoma group and there are only two patients living over five years among the twenty cases which have been followed clinically since operation. Radical surgery followed by post-operative irradiation appears to offer the only hope in patients thus afflicted. Irradiation is best given by radium implantation (11, 12).

3. *Brodie's abscess*.—One hundred years have elapsed since Brodie first described this rare clinical entity of bone, which is characterized by a small single area of medullary bone destruction due to a latent chronic in-

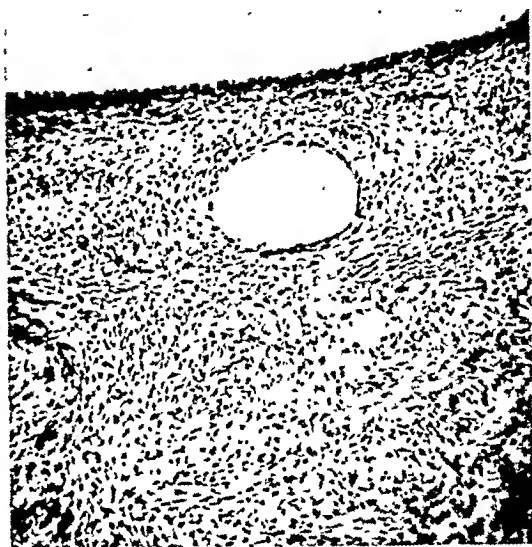


Fig. 24. A late stage in osteitis fibrosa, showing the condensation of fibrous tissue in the wall of a large cyst. A small cyst is also shown. Compare with Figure 23.

fection in the cancellous tissue at the extremity of a long bone. Males are affected far more frequently than females (five to ten times in most of the series recorded), and the predominate period of life is in the decade falling between the ages of fourteen and twenty-four years (Fig. 31). More than half of all cases reported in the literature<sup>3</sup> have been located in the tibia, the major portion of the remaining affecting the lower femur and lower humerus.

The duration and clinical symptomatology reflect the etiology of the disease. In a large percentage of the cases (84 per cent in Thomson's series<sup>4</sup>) there is a previous history of acute osteomyelitis. Students of this condition are agreed that cases of acute osteomyelitis may develop such a Brodie's abscess as a residual or complicating feature. This emphasizes the fact that contrary to a commonly erroneous conception, Brodie's abscess is not of tuberculous origin, but is most frequently dependent upon the presence of a staphylococcus infection of low virulence. Many of the patients give a history of an

<sup>3</sup>M. S. Henderson and H. E. Simon: Brodie's Abscess, *Arch. Surg.*, November, 1924, IX, 504 (Pt. 1).

<sup>4</sup>Thompson: *Edinburgh Med. Jour.*, 1906, XIX, 297.

acute and septic onset, which rapidly subsides, to be followed during the period of the next months or years by variable and usually mild pains in the affected region. In addition to this protracted history, there is

roentgenologist. Pathologic fracture is extremely rare in these lesions and has never been recorded in our series.

Pathologically the diseased area takes the form of a small island of soft granular ma-

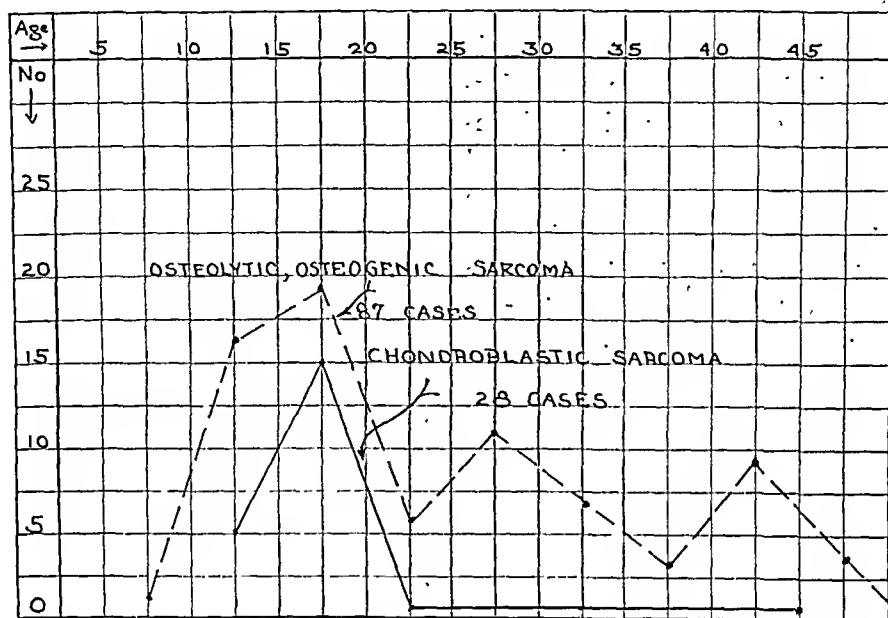


Fig. 25. Chart showing age incidence of two forms of osteolytic sarcoma. The solid line indicates chondroblastic sarcoma, and the broken line, osteolytic osteogenic sarcoma.

a fusiform swelling of the bone in the upper or lower tibia to aid in making the diagnosis clinically.

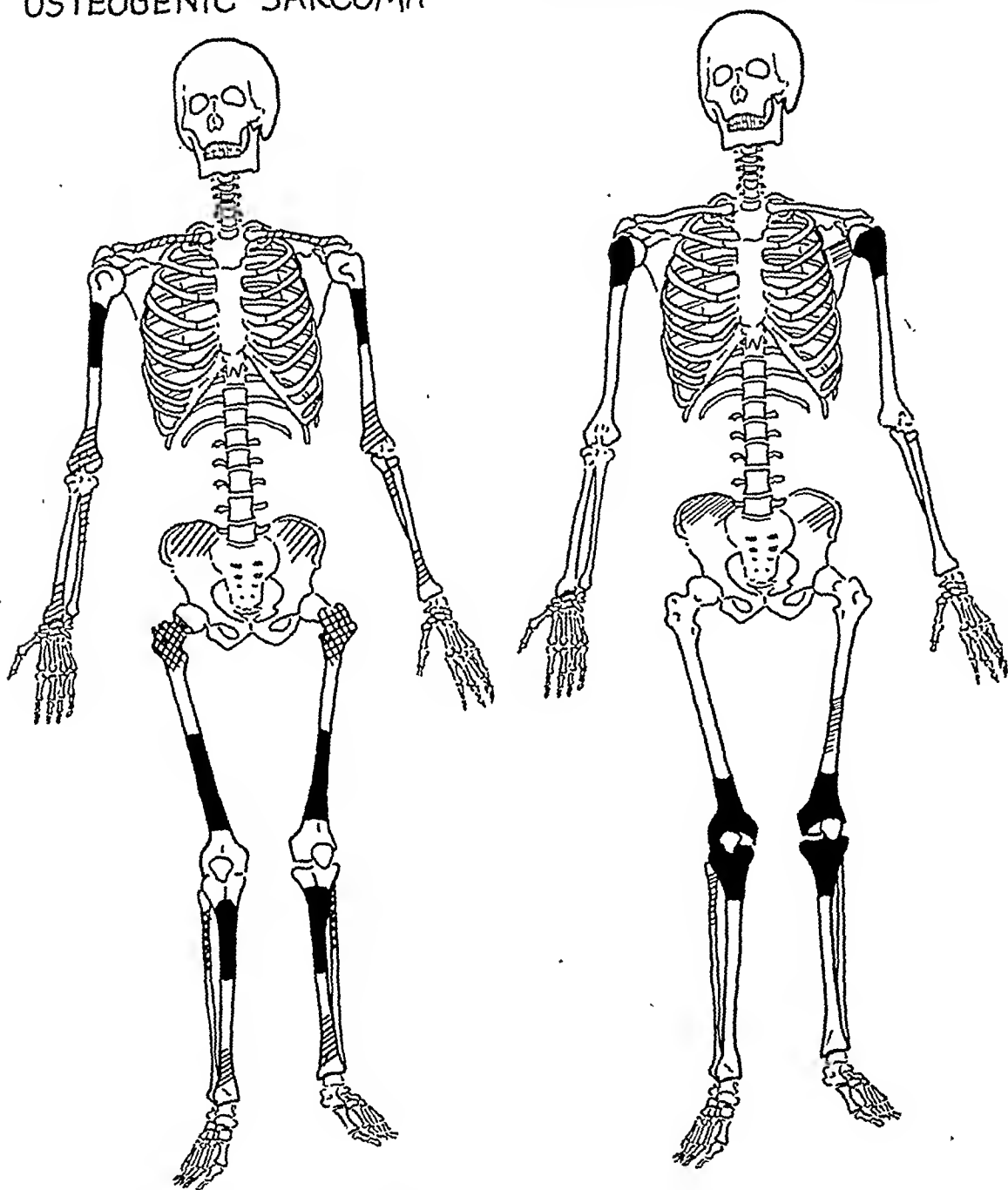
In the X-ray film the involved bone shows a more or less circular, rarefied area in a central location in the metaphyseal region of a long bone, usually the upper or lower tibia. The cortical bone about the lesion shows increase in density and expansion, which produces a definite and palpable swelling. Such a Brodie's abscess may be distinguished from a bone cyst because the involved area is considerably smaller, usually from one to two centimeters in diameter, and the neighboring cortical bone is practically always far thicker than that found in the bone cyst (Figs. 32-A and 32-B). Occasionally the area of bone destruction may be so small that it is overlooked by the

material in the medullary cavity or the small cavity filled with fluid: about this there is usually an area of increased density. The origin of the disease is due to a dormant focus of infection, carried to the medulla of the bone by the blood stream and remaining quiescent until the resistance of the patient is lowered by a general systemic disease or locally by trauma to the infected bone. The mode of infection differs from that of Garré's osteitis, which is *via* the lymphatics. Unlike acute osteomyelitis, high fever and leukocytosis are rare, but occasionally sinus formation and a sequestrum may occur. A good prognosis may be given if proper surgical evacuation of the infected area is performed (13, 14).

*Summary of osteolytic lesions in patients under twenty.*—In the differential diagnosis

# OSTEOLYTIC OSTEOGENIC SARCOMA

# CHONDROBLASTIC SARCOMA



Figs. 26-A and 26-B. Charts showing the incidence of osteolytic osteogenic sarcoma (26-A) and chondroblastic sarcoma (26-B) according to skeletal locations. The solid black areas indicate the most frequent sites; the checked areas, the common sites, and the diagonal line areas, the occasional sites.

of these three lesions—the bone cyst, the osteolytic sarcoma, and Brodie's abscess—the most helpful consideration is the condition

of the cortical bone in the neighborhood of the lesion. In the bone cyst the area of bone destruction is immediately beneath the cor-



Fig 27 Roentgenogram showing the destructive rotten-wood appearance in a long bone, the seat of osteolytic osteogenic sarcoma. The cortex has been broken through without expansion and a soft-part tumor has been produced.

tex and expands the cortical bone, which is thinned but bulges symmetrically on either side of the lesion, remaining intact unless pathologic fracture occurs. In Brodie's abscess the area of bone destruction is some distance from the cortex and the cortical bone is thickened rather than thinned, the swelling in this region being due to this thickening rather than to bulging or expansion of the cortex. In osteolytic sarcoma of the fibro-osseous type the area of bone destruction extends directly through the cortex, which early in the disease is dissolved away, along with the medullary bone. In the chondral form of osteolytic sarcoma the

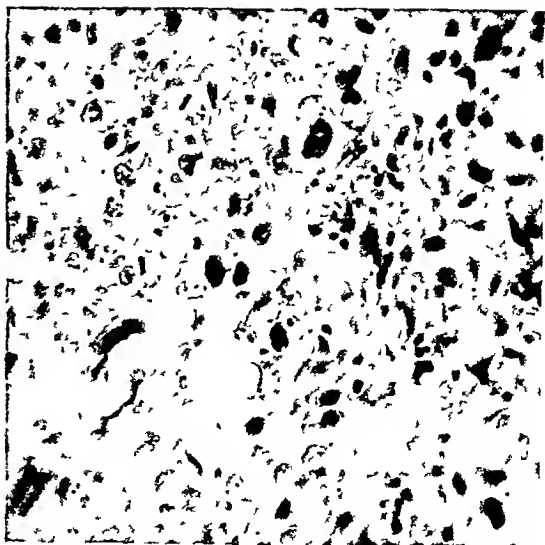


Fig 28 Photomicrograph of an osteolytic type of osteogenic sarcoma, showing the large vesicular nuclei and mitotic figures common to this type of sarcoma.

cortex may survive longer and may be thinned and expanded, but evidence that the tumor has passed beyond is visible by periosteal lipping, roughening, or by the actual presence of the translucent tumor mass in the periosteal zone.

The configuration of the area of bone destruction is also helpful in roentgenologic diagnosis. In Brodie's abscess the rarefaction is small and sharply circumscribed. In the bone cyst it is larger, may be oval or more irregular, but is definitely limited by a bone shell in all directions. In osteolytic sarcoma of the fibro-osseous type the area of bone destruction is exceedingly irregular and worm-eaten, with jagged margins extending in different directions. In the chondral form of osteolytic sarcoma the area of bone destruction is more often multiloculated and usually fades off, with a hazy margin.

### *III.—Myxosarcoma and Pyogenic and Specific Infections of Bone*

The clinical entity known as myxoma or myxosarcoma and a group of infections of

the bone warrant separate discussion at this point, since these entities do not fall readily into line with the basis of classification used for the other lesions treated in this paper, because all of them are capable of showing in the X-ray film both bone formation and bone destruction.

1. *Myrosarcoma of bone*.—Myxoma of bone, which was described as a separate form of bone tumor by Bloodgood (16), is potentially a malignant neoplasm and in the light of more recent studies is more properly classed as a secondary form of malignancy arising at the site of a previous benign osteochondroma. In the final stages the growth is histologically indistinguishable from the chondral form of osteogenic sarcoma (the so-called chondromyxosarcoma), but clinically its course is far more protracted and is unique among the sarcomas of bone. The patients with such a lesion are adults over thirty years of age and are often unaware of a pre-existing exostosis or chondroma. Usually a history is obtained of rheumatic pains, extending back over a number of years (two to twenty), referable to the region of the tumor. Exacerbation of the symptoms such as severe pain or increase in swelling, brings the patient under observation. The degree of malignant change and the grade of the malignancy may vary greatly in such a lesion, and it is difficult to predict from either the X-ray film or the microscopic appearance the course of the disease if radical surgery is not instituted (Figs. 33-A and 33-B).

In the X-ray films the discovery of the remnant of the earlier benign osteochondroma may be relatively easy or exceedingly difficult. If the malignant change is early, the cartilaginous cap of the tumor may be seen invading the base of the exostosis and encroaching upon the medullary cavity. If the growth is more advanced, the previous ossification in the osteochondroma may be scattered as granular débris in the enlarging



Fig. 29. Roentgenogram of a chondroblastic sarcoma in the upper end of the humerus. The tumor has the typical multilocular formation of a cartilaginous lesion and the periosteal reaction of a sarcoma. The area of bone destruction is located at an epiphyseal line, extending into both the epiphysis and the shaft.

translucent tumor mass and nothing of the original exostosis may remain except the congenital defect of the widened metaphysis (Figs. 34-A, 34-B, 34-C).

If the lesion is treated by local excision, it may recur repeatedly. In not a few instances such tumors have recurred as many as from five to fifteen times following repeated cauterization over a period of six to eight years, eventually ending in a complete destruction of bone at the tumor site and the death of the patient from pulmonary metastasis. Apparently the best mode of treatment of such lesions when the histology is that of an outspoken chondromyxosarcoma (Fig. 35) is by radical resection, or amputation when possible.

2. *Osteomyelitis, tuberculosis, and syphilis of bone*.—These three entities of



osteomyelitis, tuberculosis, and syphilis are mentioned here more for the purpose of ruling them out of the discussion of the differential diagnosis of bone tumors by the

ness near the epiphyseal line of a long bone, without involvement of the neighboring joint, is ample presumptive evidence for the diagnosis of an acute osteomyelitis. Ex-

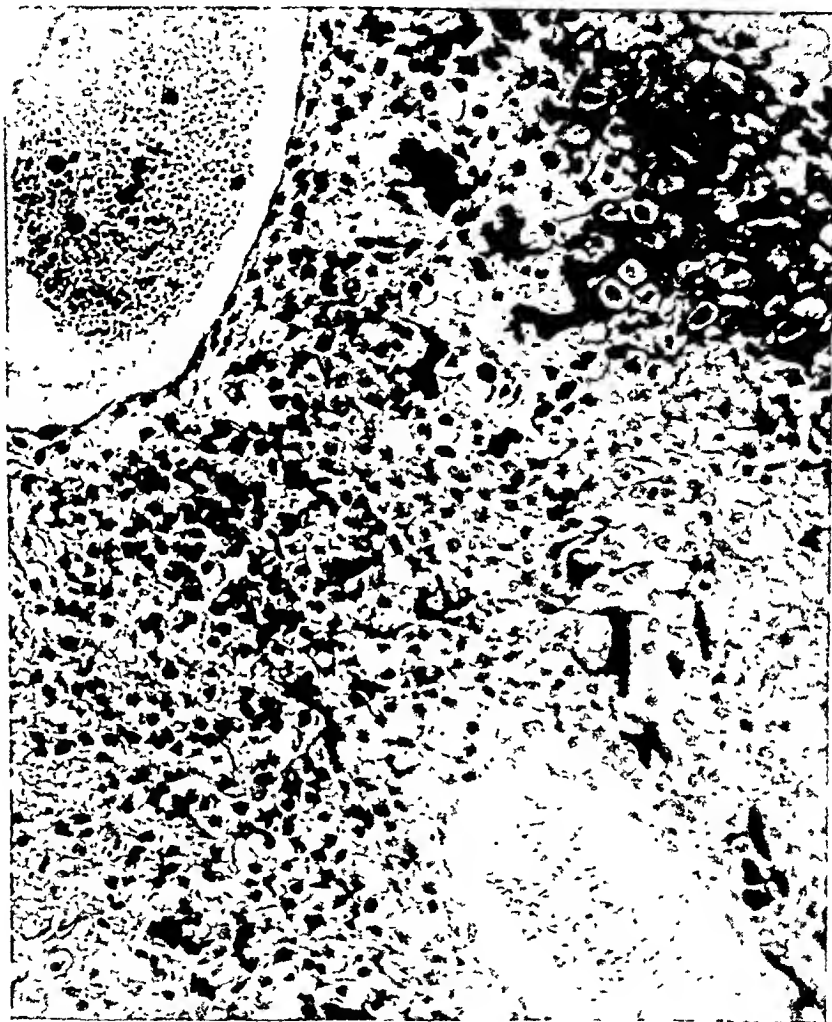


Fig 30. Photomicrograph showing the chondroblasts, the cartilage, and the abortive calcification in a chondroblastic sarcoma. The capillaries in the illustration indicate the vascularity of this sarcoma.

X-ray, than for the purpose of detailed consideration. The diagnosis of all three of these conditions depends primarily upon the clinical picture rather than upon the X-ray.

In a child between the ages of two and ten years, the occurrence of high fever ( $103-104^{\circ}$ ), leukocytosis (25,000-30,000), and a toxicity indicative of an acute infection, plus localized pain and point tender-

ploration by the surgeon should follow, and confirmation by X-ray examination, which is negative at this stage of the disease, should not be awaited.

The X-ray picture of an acute osteomyelitis is characteristic only when surgical intervention is delayed. At this stage there is generally evidence of bone destruction and new bone formation. The bone affected is

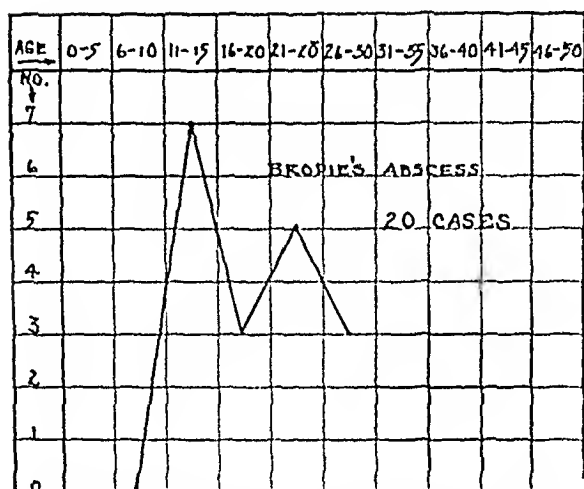


Fig. 31-A. Chart showing the age incidence of Brodie's abscess.

typically that of a child under ten and the area of involvement is most frequently in the upper end of the tibia, the lower end of the femur, the lower ends of tibia and fibula, the upper end of the humerus, or the lower end of the radius. As Starr has stated, the area of involvement is generally triangular (Figs. 36-A and 36-B), with the base toward the epiphysis and the necrotic areas sloping away toward the mid-shaft and toward the periosteum. The periosteum is stripped for some distance by the collection of pus and gives evidence of an involucrum beneath by a dense shadow of new bone formation. Bone destruction, with the formation of sequestrum, is the rule. If the disease become chronic, new bone formation becomes more and more marked and irregular in character. Pathologic fracture may occur.

In tuberculosis of bone, which is also characteristically a juvenile disease, although the local focus of origin is generally in the epiphysis of the bone, the symptomatology and the deformity practically always point to one of the joints, the spine, hip, knee, and ankle being involved in frequency in the order mentioned. Chronicity and deformity are the outstanding features of this disease, the deformity being caused by either

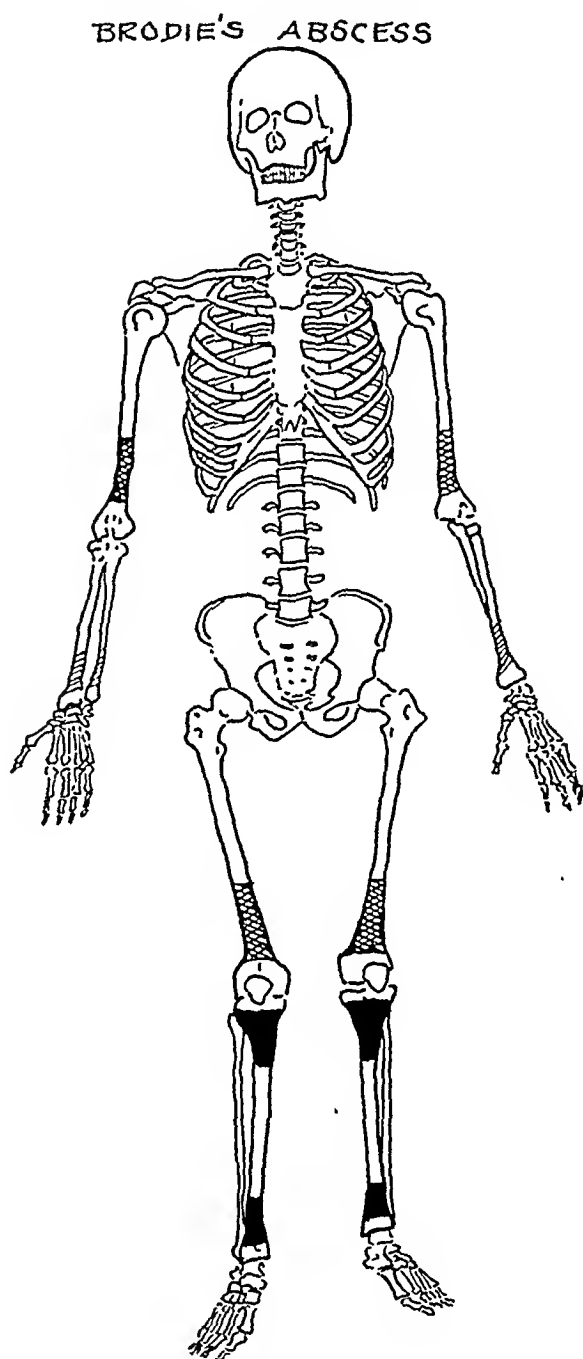


Fig. 31-B. Chart showing the skeletal distribution of Brodie's abscess. The black areas indicate the most frequent sites; the checked areas, the common sites, and the diagonal line areas, the occasional sites.

muscle spasm, shortening brought about by limitation of bone growth, or actual bone destruction. In the spine, the characteristic deformity is kyphosis in the dorsal region. In the hip, a flexion deformity, with short-



Fig. 32-A Lateral view of a Brodie's abscess situated in the lower end of the tibia. The small size of the bone defect, the periosteal swelling, as well as the location in the tibia are diagnostic. Nearly 90 per cent of all these lesions occur in the long bones.

ening of the leg, is typical. In the knee, flexion deformity plus the classical white swelling, accentuated by atrophy below, is outstanding, while in the ankle, plantar flexion, with similar swelling, is characteristic. As in osteomyelitis and syphilis, systemic features of the disease play an important part in the diagnosis. The loss of weight, elevation of temperature in the afternoon, and systemic tuberculosis elsewhere in the body aid in making the diagnosis. In addition, the development of a cold abscess or a persistent draining sinus is typical.

In the X-ray examination of tuberculosis, there is seen melting away of the bones to give a diffuse hazing in the region of a joint (Fig. 37). The location in the spine, at the



Fig. 32-B. Antero-posterior view of same case as shown in Figure 32-A (which see)

hip, knee, or ankle is also characteristic. Calcified bodies about the bone in the joint or soft parts are not unusual. Subluxation of the bones occurs, while in the late stages synostosis may appear, with healing, although surgical intervention is usually necessary to bring this about. Collapse of the vertebræ and actual dislocation of the hip may occur and some evidence of sinus formation may be visible in the X-ray film.

Syphilis of the bone, which may be congenital in the newborn but which is more

often a disease of adults between the ages of twenty and forty, is a secondary or tertiary phenomenon, although syphilitic periostitis has been described as occurring synchronously with the primary sore or from

the typical saber-shin may develop if the case is a congenital one. This is marked by some bowing of the tibia, accentuated by new bone formation, incident to both periostitis and osteitis (Figs. 38-A, 38-B, 38-C).

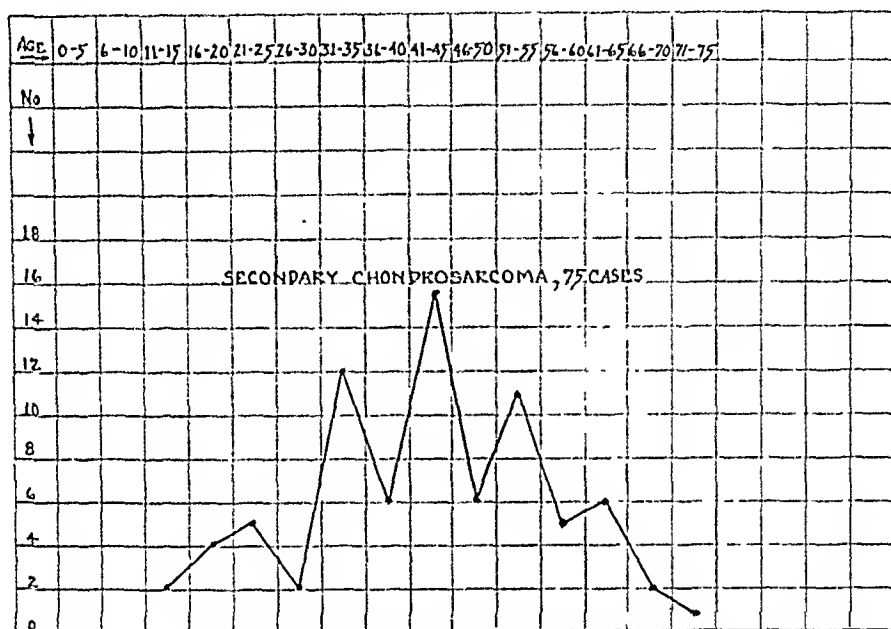


Fig. 33-A. Chart showing the age incidence of myxosarcoma or secondary chondrosarcoma of bone.

two to fifteen weeks thereafter. The history of exposure and of a primary sore plus a positive blood Wassermann are essential points in the diagnosis. The osteocopic night pains are helpful but not pathognomonic. Early involvement of the bone is generally restricted to a periostitis, which affects most frequently the cranium, ribs, sternum, and the tibiae. This periostitis yields readily to anti-syphilitic treatment, restoring the bone to normal, and such a therapeutic test establishes the diagnosis beyond question. In the late stages of bone involvement, gummas are usually present in the affected region, which is most frequently the tibia, and give a nodular character to the bone on palpation.

In the X-ray picture of syphilis which has gone beyond the stage of simple periostitis, Gummatous osteomyelitis in adults leads

to an extensive change over a wide area of bone, dependent upon both bone destruction and new bone formation, in which bone destruction generally predominates, producing very irregular bone, with mottling. The bone deformity resembles an ordinary chronic osteomyelitis in these cases, but may be even more severe, with more mottling and irregularity. Pathologic fracture is prone to occur in gummatous osteitis (17, 18, 19, 20.)

#### IV.—Ossifying Periosteal Lesions in the Adult

While osteogenic sarcoma of the periosteal ossifying type may occur in the latter decades, it is not the usual lesion of this type after the age of twenty. Periosteal fibrosarcoma, however, does occur in pa-

## SECONDARY CHONDROSARCOMA

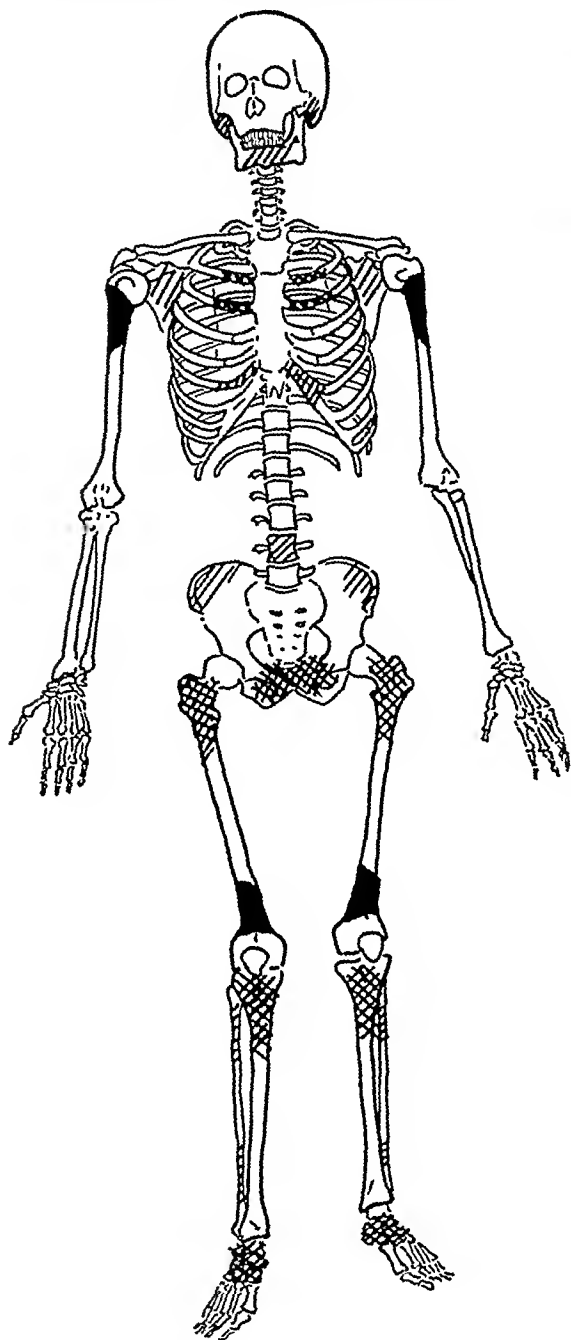


Fig. 33-B Chart showing the skeletal distribution of myxosarcoma or secondary chondrosarcoma of bone. The black areas indicate the most frequent sites; the checked areas, the common sites, and the diagonal line areas, the occasional sites

tients over thirty, although, strictly speaking, it does not ossify. Myositis ossificans of the traumatic circumscribed type and ossifying periostitis on an inflammatory or



Fig. 34-A A case of secondary chondrosarcoma superimposed upon a benign cartilaginous lesion. There is shown here the sarcomatous transformation producing medullary destruction, with pathologic fracture and also a periosteal tumor in the humerus which was the site of a congenital malformation.

traumatic basis, are both diseases of adulthood which may produce ossification in this region of the bone.

1. *Periosteal fibrosarcoma*.—This is a relatively infrequent sarcoma of bone which affects the fibrous layers of the periosteum, and is, strictly speaking, a fascial sarcoma, since it does not arise from osteogenic tissue. This form of fibrosarcoma is of a relatively low degree of malignancy, nearly one-half of the patients being reported well over a period of from two to ten years after operation. Males and females are affected in about equal proportion. The age of distribution of this tumor is characteristic and very unusual for sarcoma (Fig. 39-A). In a series of forty cases, thirty-one are thirty years of age or over. Most of the patients are between thirty and fifty years of age, but a good portion are even older, the oldest patient recorded being seventy-five years. This tumor is typically

a single lesion occurring in the periosteal zone and frequents the usual favorite sites of sarcoma of bone—about the knee in the lower femur and upper tibia (Fig. 39-B). The average duration of symptoms is ap-

proximately thirty months, and swelling is a more prominent feature than pain. The average duration of symptoms is approximately thirty months, and swelling is a more prominent feature than pain.



Fig 34-B. Same case as shown in Figure 34-A. Here is seen the original nature of the benign chondromatous lesions which also affected the hand.

proximately thirty months, and swelling is a more prominent feature than pain.

The X-ray appearance is variable but in most instances is characterized by a cloudy soft-part shadow and secondary bone necrosis. The tumor begins in the periosteal zone, but is unique in extending both outside of and beneath the periosteum. This two-fold mode of growth is explained by the tissue of origin, which is the outermost fibrous layer of the periosteum. The periosteal shadow of the tumor and that extending into the soft parts is visible as a diffuse haze without definite demarcations in the roentgenogram. Rarely there is slight calcification or new bone formation, due to the carrying up into the tumor of

the periosteal type are not sarcomas but fibromas, and this accounts for the large percentage of five-year cures (Figs. 41-A and 41-B). Fibrosarcoma is to be suspected in the X-ray film when there is a soft-part shadow continuous with the bone of a hazy but not translucent quality, without radiating spicules of bone in the shadow, and when the bone beneath is melted away from without, inward, in an asymmetrical manner. The osteolytic form of osteogenic sarcoma, it will be remembered, destroys the bone from within, arising in the medullary cavity and rarely extending beyond the cortex. The chondromyxosarcoma form of osteogenic sarcoma gives a more translucent periosteal shadow, with small radiating

spicules of new bone, and definitely lifts the periosteum. Such is not the case in fibrosarcoma.

The prognosis in this form of sarcoma depends upon the cellularity of the micro-

far the more frequent. The trauma may be single or repeated, due to some occupational habit. The occupational form was the first to be described (Billroth, 1855), under the term "rider's bone," and later under the



Fig. 34-C. Photomicrograph showing the cartilaginous structure of the tumor in the humerus.

scopic structure, and radical treatment, such as amputation, should not be tried unless the pathology is carefully checked by biopsy (21, 22).

2. *Myositis ossificans*.—Various forms of myositis ossificans have been described. The progressive, diffuse form, which begins in children with other congenital defects, such as microdactylism, and involves successive muscles, beginning usually in the trapezius or latissimus dorsi, is not dealt with here. Varieties of the circumscribed type of myositis ossificans are generally classified under the traumatic and non-traumatic forms, of which the traumatic type is by

term "drill bone," both of which are common among enlisted men in the cavalry and infantry, respectively. The ossification of the deltoid muscle, due to the rifle, and of the adductors in the thigh, due to the pressure of the saddle, has been termed the "Prussian disease," since so many of the reports have come from that source (Kuttner<sup>5</sup>).

In this country traumatic myositis ossificans of the circumscribed type is most frequent following a single injury, and is seen most often following posterior dislocation

<sup>5</sup>Kuttner: Die Myositis ossificans circumscripta. *Ergebn. d. Chir. v. Orthop.*, 1910, I, 49-106.

of the elbow producing ossification in the brachialis anticus, and injuries of the quadriceps femoris in foot-ball players. Among the thirty cases of this form of circumscribed myositis ossificans recorded in the Surgical Pathological Laboratory, involvements of these two muscles predominate (Fig. 42). Patients between the ages of twenty and forty are in the majority, the maximum age in this series being forty-three (Fig. 43). Cases occurring under twenty are not rare, but more elderly patients are unusual. Females are very rarely affected—only once in our series. The history is characteristic. Following a severe injury, there is hemorrhage into the muscle, with the formation of a hard tumor, with ossification within a period of from three to six weeks. The injury is commonly received either in foot-ball or accidentally in some occupation, such as mining, mill-working, etc.

In the X-ray film there is a single lesion showing a more or less wedge-shaped area of laminated bone, separated from the normal bone usually by a definite interval of soft parts. The edges are usually smooth and well outlined and the location is commonly near the elbow or in the thigh. Dean Lewis emphasizes a tendency for the area of ossification to attain its maximum rapidly, and then to remain stationary or decrease. The diagnosis of such a lesion by the X-ray, when there is a definite history of trauma, is not difficult. However, variations of this picture occur in which the wedge of new bone may adjoin the shaft of the normal bone beneath, and one free edge may be extremely irregular. The irregular edge, infiltrating the muscles, may assume the characteristic of the so-called dotted-veil, while the fact that new bone occurs only at one side of the normal bone, and does not surround it, is helpful in diagnosis. Rarely the ossification may be extensive and simulate osteogenic sarcoma, as in the cases



Fig. 35. Secondary chondromyxosarcoma arising at the site of an old exostosis in a white male, aged 25. The X-ray film shows the original base of the exostosis and the splintering of bone and spotty calcification typical of secondary chondromyxosarcoma.

of Chambers, Paul (23), and one of Coley's (24). The simulation of such a form of myositis ossificans to sarcoma is not only apparent but real, since a definite percentage of these cases with extensive irregular ossification become malignant after an interval of years, recurring in spite of excision, to produce ultimate metastases and death (Fig. 44).

Histogenetically, the source of the new bone is fibrous strands in the muscle, or tags of pre-cartilaginous embryonic connective tissue (blastema) displaced from the primitive periosteum; however, the reason for the heterologous ossification at these sites in the muscle is obscure. A hematoma seems to be an important antecedent to the ossification. Dean Lewis<sup>6</sup> emphasizes peri-

<sup>6</sup>Jour. Am. Med. Assn., May 5, 1926, LXXX, 1281.



osteal stripping by injury as a source of the new bone. This would account for some types which show direct ossification of the membranous type, but would not account for the myositis ossificans derived *via* cartilage

scure in nature. In the lower abdomen, the blastemal strands in the rectus abdominis in the region of its attachment to the pubis may be a source of the ossification, while in the upper abdomen, similar strands at the inser-



Fig 36-A Roentgenogram of an osteomyelitis in a child aged four. The area of bone destruction invades the epiphysis, and the periosteal reaction, with new bone, slopes upward beyond the mid-shaft region

(Fig 45), which must involve strands of blastemal tissue. The dotted-veil appearance in the X-ray film, extending out into the muscle, is against the assumption that periosteum of any size has been displaced, since, as a limiting membrane of ossification, it tends to produce more circumscribed formation. In such cases, if displacement of periosteal tissue plays a rôle, it must be by the dispersion of cells or groups of cells from the cambium layer. The ossification in the abdominal wall following surgical incisions, reported by Lewis, is more ob-

tion of the ribs may account for the development.

The prognosis in these cases is usually favorable. The symptoms attending the ossification may subside spontaneously, or, if persistent, will usually disappear with the surgical removal of the growth (23, 24).

3. *Ossifying periostitis*.—This is not a separate clinical entity but a phase of bone disease seen in such diseases as non-suppurative osteomyelitis of Garré, and syphilis. It is a benign condition which appears not infrequently about the tibia, humerus, or

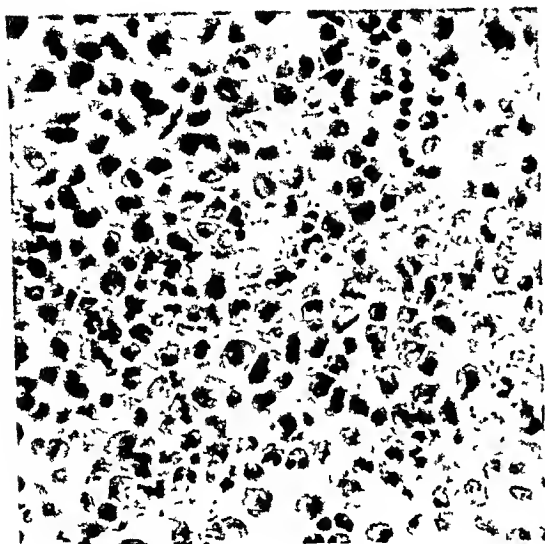


Fig 36-B Photomicrograph showing the leukocytic infiltration typical of osteomyelitis

femur, as a single lesion in adults, generally between the ages of from fifteen to thirty-five. The usual basis for this dense ossification, producing a subperiosteal swelling, is either trauma or syphilis, and in no case should a Wassermann be omitted on a patient with such a lesion. The involved area is definitely circumscribed in most instances (Fig 46) and affects usually one surface of the bone. When more diffuse and on the

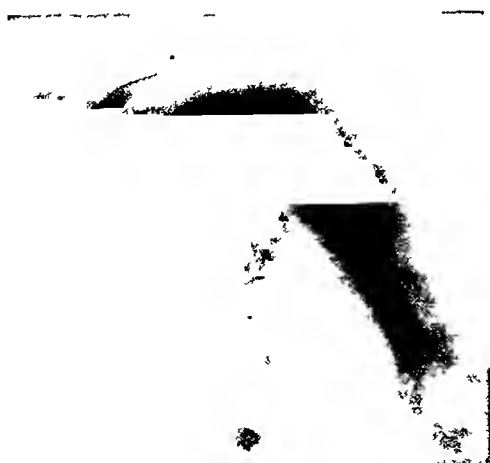


Fig 37 Roentgenogram of a tuberculous humerus showing marked destruction in the epiphyseal end of the bone, with involvement of the joint



Fig 38-A This illustration, together with Figures 38-B and 38-C, depicts the bone-formative, the bone-destructive, and the microscopic phases of syphilis of the bone. There is sclerosis and new bone formation, with a periosteal involvement. This is an unusual picture in syphilis of an ossifying type which is more often restricted to the periosteum.

basis of a low-grade chronic infection of the lymphatics in young adults, the reaction is referred to under the term "Garre's non-suppurative osteomyelitis."

Ossifying periostitis is a chronic disease, the usual duration of symptoms averaging

nearly eighteen months and in some cases extending back for from fourteen to sixty years. Pain, swelling, and some stiffness in

granulation tissue may be due to infection, following abscesses elsewhere in the body, or previous systemic infection by typhoid.



Fig. 38-B. A bone-destructive process, with periosteal involvement more characteristic of advanced syphilis.

the neighboring joints are the usual symptoms. In 10 per cent of the cases a definite abscess, carbuncle, or furuncle elsewhere in the body is associated with the development of the lesion. In over 10 per cent of the cases a positive Wassermann is present. One-fifth of the patients give a history of severe trauma.

Histologically, the areas of ossification are caused by raising of the periosteum, following the formation of granulation tissue or hemorrhage beneath this membrane. The

syphilis, or influenza. The hemorrhages are most often the result of trauma. The degree of ossification produced by such subperiosteal disturbance is dependent upon the extent and character of the injury and the age of the patient. In younger patients, ossification is more pronounced, and in rapidly subsiding infections and single traumas, new bone formation is likewise marked. In severe persistent infections, and in older patients, however, osteoporosis is always an accompanying feature.

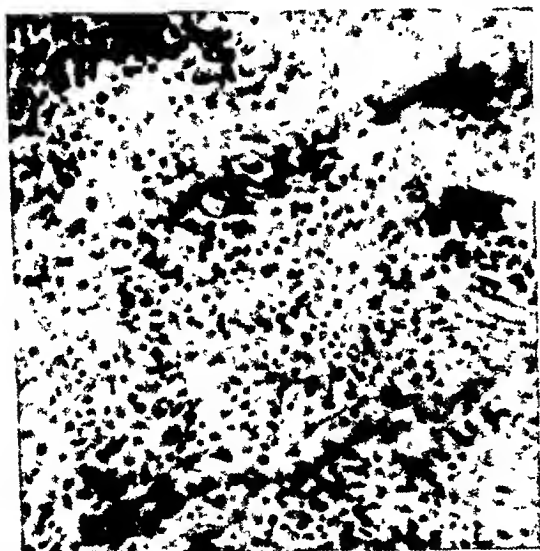


Fig. 38-C. Shows the inflammatory character of the lesion under the microscope, usual for syphilis, but also similar to that seen in tuberculous involvement of the bone.

in the adult.—In the differential diagnosis of ossifying periosteal lesions in the adult, it is important to bear in mind that there is an age overlap between the periosteal lesions more prevalent before the age of twenty, such as exostoses, periosteal osteogenic sarcoma, Ewing's sarcoma, and Garré's osteitis, described in Section I, and the fibrosarcoma, ossifying myositis, and ossifying periostitis just discussed. It may be difficult to distinguish between sclerosing osteogenic sarcoma, myositis ossificans, and ossifying periostitis in the roentgenogram. In differentiating between these three lesions, the location is an extremely helpful consideration. Osteoblastic osteogenic sarcoma arises from the subperiosteal region of the metaphysis, rapidly distorts the periosteal border

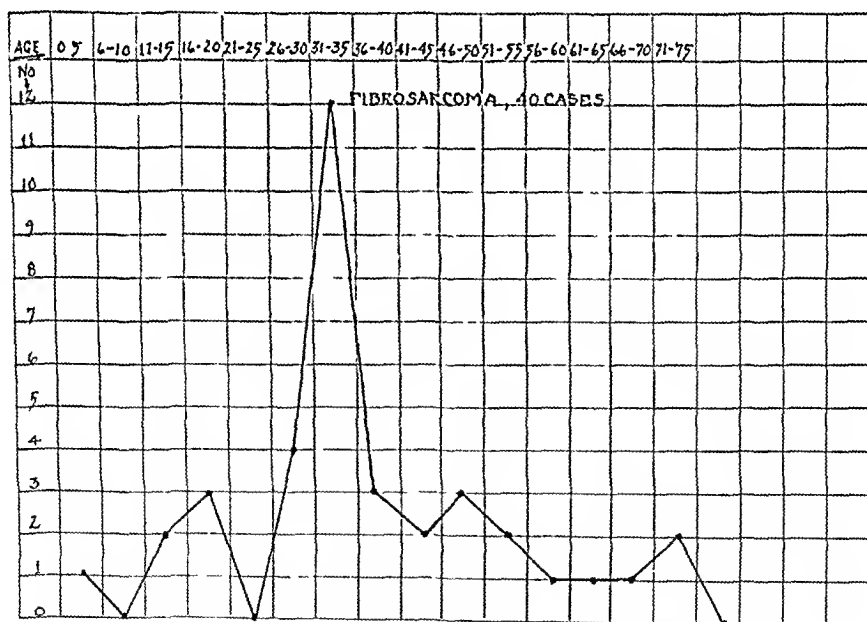


Fig. 39-A. Chart showing the age incidence of periosteal fibrosarcoma.

Incision of the periosteum, with scraping of the underlying bone, is usually a successful mode of treatment in protracted cases, other than of the syphilitic type.<sup>7</sup>

#### Summary of ossifying periosteal lesions

<sup>7</sup>For literature, see Section on Garré's Osteitis, Pt. I, Par. 4, Page 129.

with irregular ossification, and produces medullary sclerosis by infiltration of the marrow cavity. Myositis ossificans arises above the periosteum within the muscle and although the superimposed shadow may obscure the underlying normal bone, if proper views are taken this suprapariosteal location

## FIBROSARCOMA

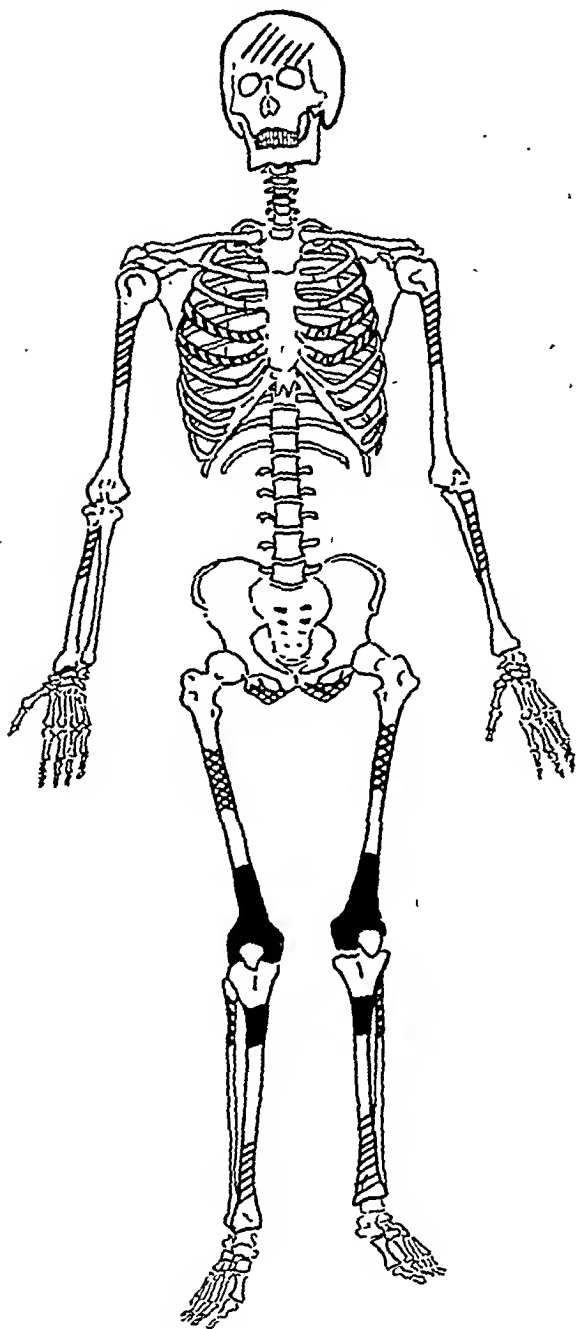


Fig. 39-B. Chart showing the skeletal distribution of periosteal fibrosarcoma. The solid black areas indicate the most frequent sites; the checked areas, the common sites; the diagonal line areas, the occasional sites.

of the ossification will be disclosed. Ossifying periostitis is a relatively slow mode of ossification laid down beneath the perios-



Fig. 40. Roentgenogram of a periosteal fibrosarcoma showing the large soft-part swelling and a slight amount of secondary new bone destruction.

teum, usually in a region near the mid-shaft. The ossification does not invade the marrow cavity as in sclerosing sarcoma, nor is it as irregular and radiating in character, but instead, is more often parallel to the bone and more regular.

The resemblance of the advanced stage of Ewing's tumor to ossifying periostitis which is accompanied by osteoporosis may be a source of confusion to the roentgenologist. The onion-peel formation of the periosteum in Ewing's tumor is a helpful point in the diagnosis and the degree of ossification is generally more pronounced in the inflammatory lesions than in Ewing's sarcoma. The differentiation, however, may require biopsy. The location and the character of the soft-part shadow in fibrosarcoma should permit a more ready diagnosis.

## MYOSITIS OSSIFICANS

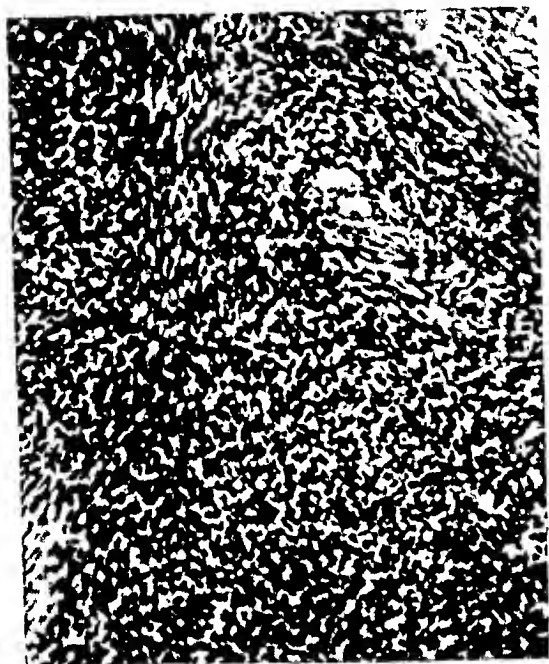


Fig. 41-A. A cellular type of fibrosarcoma in which the cells are the small oat cell type and mitotic figures are numerous.



Fig. 41-B. Photomicrograph of a low-grade fibrosarcoma showing the fibromatous character of the tissue. Patients with this type of tumor do not succumb to metastasis. The lesion is best termed a fibroma.

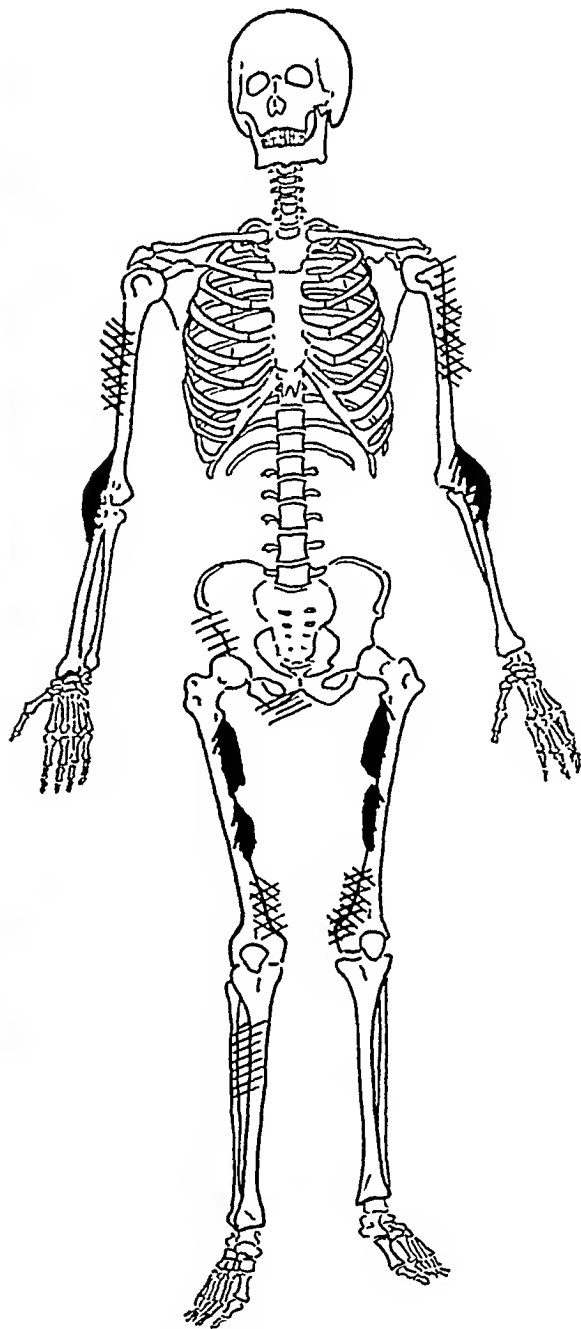


Fig. 42. Chart showing the incidence of myositis ossificans according to skeletal location. The solid black areas indicate the most frequent sites; the checked areas, the common sites; the diagonal line areas, the occasional sites.

### V.—Solitary Osteolytic Tumors in Patients over Twenty

Among those tumors which produce in the X-ray film a single area of medullary

bone destruction in adults over twenty, we must consider the benign giant-cell tumor of bone, the central chondroma or chondro-

myxoma, the single focus of metastatic carcinoma to bone, and the more infrequent latent bone cyst. Multiple myeloma in bone rarely presents itself initially as a single lesion early in the disease (Geschickter).

femur, and the lower radius are most frequently involved. The typical configuration of the tumor is a globular, trabeculated, rarefied area, asymmetrically located. Comparison of early and late lesions on the

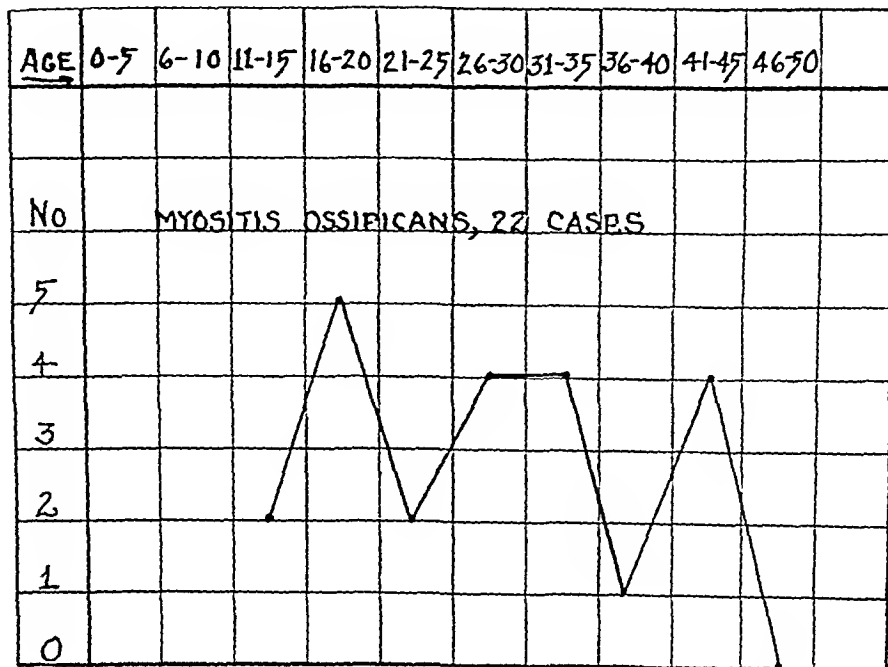


Fig. 43. Chart showing the age incidence of myositis ossificans.

and the possibility of this must be borne in mind.

1. *Benign giant-cell tumor.*—This benign lesion of bone occupies a relatively important position among the bone tumors, because of its frequency. The peak of the age incidence of this tumor occurs between twenty and thirty years (Figs. 47-A and 47-B), and females are slightly more often affected than males. Clinically, the lesion is progressive, with an average duration of symptoms of fourteen months, the usual sequence being trauma, pain, tumor, and fracture. The area of involvement is practically always single and shows in the roentgenogram as a circumscribed, bone-destructive lesion occurring in an epiphysis. The epiphyses of the upper tibia, the lower

X-ray films shows that the area of bone destruction begins in a subcortical location at one side of the epiphysis and works its way toward a more central location at the expense of cancellous bone (Fig. 48). The expanded bony shell of the tumor is extremely thin and in slightly less than 60 per cent of the cases is perforated. Pathologic fracture occurs in 14 per cent of the cases.

Histogenetically, the giant-cell tumor, with its cellular stroma pervaded by many large multinucleated giant cells containing from fifteen to two hundred nuclei (Fig. 49), is an exaggeration of the normal process of resorption of calcified cartilage by giant osteoclasts in intracartilaginous ossification which may occur in the epiphysis at any age throughout life. Giant-cell

tumors are related to bone cysts in that the histologic basis of each is usually the same, but whereas the bone cyst occurs in an earlier decade in a metaphyseal region, where ossification is in progress on the shaft side of the epiphyseal line during the growth period, the giant-cell tumor is practically always confined to the epiphysis, where the same type of ossification is not complete until late in life. The histogenesis and relation of these two tumors have been fully discussed in a previous contribution (Geschickter and Copeland, 9). From an X-ray standpoint it is important to bear in mind that these tumors arise only in bone derived from cartilage and are coincident with the normal resorption of calcified cartilage by giant-cell osteoclasts, a fact which gives these tumors their characteristic location and age distribution.

Giant-cell tumors are curable by prolonged X-ray therapy in proper doses, and by curettement. Although over 15 per cent of the curetted cases recur, the lesions are distinctly benign, and do not metastasize. The scattered metastatic giant-cell tumors recorded in the literature are few in number and have not yet been verified (Geschickter and Copeland, 12) (25, 26).

2. *Central chondroma or chondromyxoma.*—The benign central chondromas and chondromyxomas are less frequent lesions than the giant-cell tumor and have quite a different distribution in the skeleton. These tumors occur most frequently between the ages of twenty and thirty and are more frequent after the age of thirty than before the age of twenty (Fig. 50). Males and females are affected with approximate equality. The tumors are usually single but may be multiple. They are always bone-destructive rather than bone-formative in nature and are central in location.

The clinical symptoms are never very severe, but are protracted, dating back frequently several years. The chondromas are



Fig. 44. Roentgenogram of a case of myositis ossificans showing the typical laminated structure of the bone deposits and the so-called "dotted veil" appearance.

not to be confused with the osteochondromas. These osteochondromas or exostoses, which have been discussed previously in this paper, are strictly periosteal lesions and have a different seat of origin than the chondromas, despite the fact that they may contain large portions of neoplastic cartilage indistinguishable under the microscope from the tissue characteristic of the central chondromas. The chondromas, on the other hand, have a characteristic distribution and a distinct mode of origin. This group of cartilaginous, bone-destructive tumors are practically restricted to the small bones of the hands and feet and to the articular regions of the spine and the sternocostal joints



(Fig. 51). In a series of seventy cases in the Surgical Pathological Laboratory of the Johns Hopkins Hospital, there were only three central chondromas in the long bones—two in the femur and one in the shaft of

these joints are laid down by strands of primitive pre-cartilaginous connective tissue which cut across the axis of the future bones at right-angles (Fig. 52). These pre-cartilaginous strands are the same type of blas-



Fig 45 Photomicrograph of new bone formation proceeding from fibrous tissue without the presence of cartilage, typical of the majority of cases of myositis ossificans

the humerus. In order to understand the characteristics of this group of tumors and the peculiarity of their distribution, it is necessary to precede the X-ray studies by a discussion of their histogenesis.

Most of the chondromas and chondromyxomas represent histogenetically supernumerary joint cartilages. In the regions where they predominate—the hands and feet, the spine, ribs, and sternum—there are far more joints and articular surfaces than elsewhere in the body. Embryologically,

tendon tissue which forms the osseous ends of tendons and gives rise to the abnormalities of exostoses and osteochondromas. This accounts for the similarity histologically between the chondromas and the exostoses. In forming the joints this pre-cartilaginous tissue undergoes mucoid regressive changes to form the synovial lined joint cavities. However, aberrant persistent strands which do not thus regress are responsible at a later date for the origin of cartilaginous islands in the bone which form



Fig. 46. A case of ossifying periosteitis showing dense, irregular new bone formation and a characteristic limitation to one side of the bone. This patient has had X-ray examination recently and the process has remained stationary for seven years.

found most frequently in those parts of the body where there are the greatest number of joints.

In the X-ray films the typical chondroma is a small, translucent, rarefied area occurring centrally in the shaft of a phalanx. The cortical bone about the lesion is thinned and expanded, and pathologic fracture occurs in about 10 per cent of the cases (Figs. 53-A and 53-B). Unlike the osteochondromas, neither new bone formation nor calcification is characteristic of these lesions, although trabeculae of dense fibrous tissue may be visible in the roentgenogram. Recurrences after incomplete operation and secondary malignant changes are occasionally reported in this group of tumors, but complete excision usually suffices to cure the condition, if young cartilage cells are not transplanted in the wound (27, 28).

3. *Metastatic carcinoma to bone.*—Metastatic carcinoma to bone is usually secondary to malignant tumors of the breast, prostate, thyroid, or to a hypernephroma. Growths in the bone secondary to carcinoma of the gastro-intestinal tract or the female genitalia are not rare, and cancers

the chondromas and chondromyxomas. It is for this reason that the chondromas are

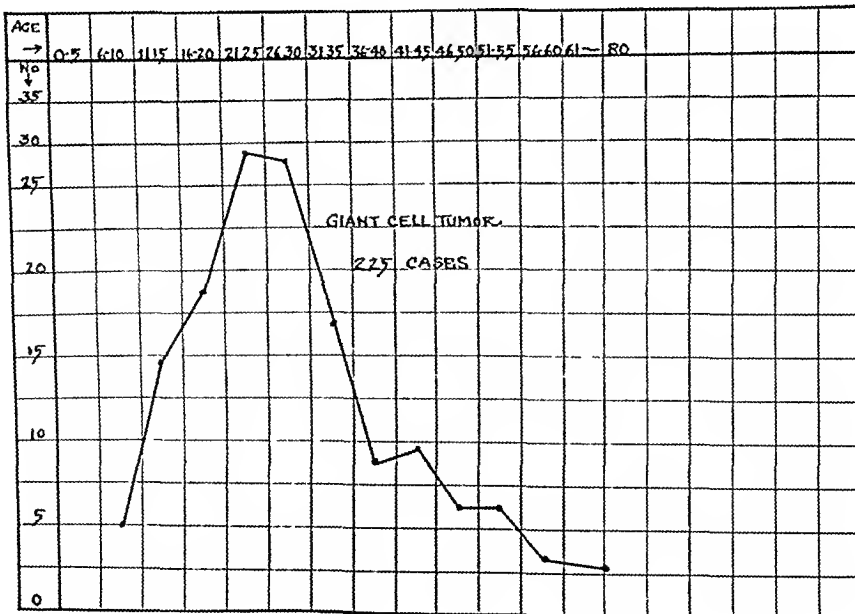


Fig. 47-A. Chart showing the age incidence of giant-cell tumor.

## GIANT CELL TUMOR

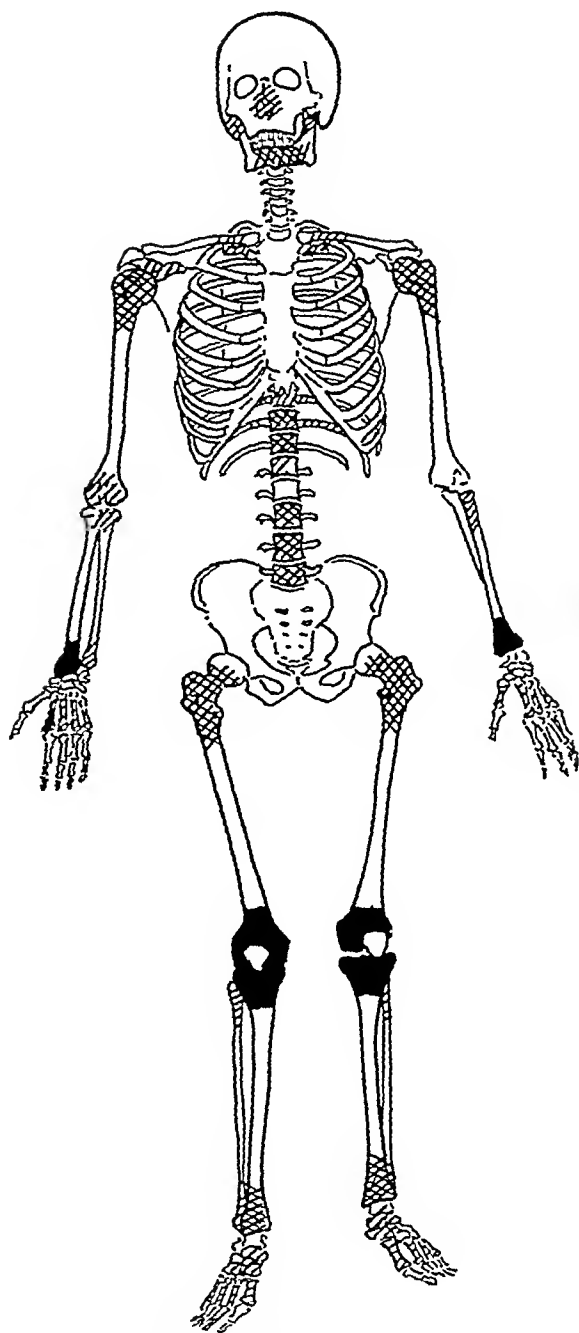


Fig. 47-B. Chart showing the incidence of giant-cell tumor according to skeletal location. The solid black areas indicate the most frequent sites; the checked areas, the common sites; the diagonal line areas, the occasional sites.



Fig. 48. Roentgenogram of a giant-cell tumor showing the epiphyseal location of the lesion, the asymmetrical expansion of the cortex, and the bone-destructive character of the growth.

foci may be multiple or single or may arise by metastases either through a hematogenous or lymphatic route. A single focus of metastatic carcinoma in a long bone is generally the result of dissemination *via* the blood stream, and arises at the point of entrance of the nutrient vessel of the bone. The multiple foci which may arise from dissemination either *via* the lymphatics or blood stream will be discussed separately, below, under Multiple Tumors of the Bone.

Metastatic carcinoma of the bone is always a hopeless disease and occurs most frequently after the age of forty, with a maximum incidence in the decade of from fifty to sixty years. Females are affected more often than males. Pain of severe rheumatic character is the important clinical feature, but more helpful is the clinical discovery of the primary tumor elsewhere in the body. In the X-ray film the character-

of the skin or mucous membrane anywhere in the body may give rise to skeletal foci in the later stages of the disease. Such

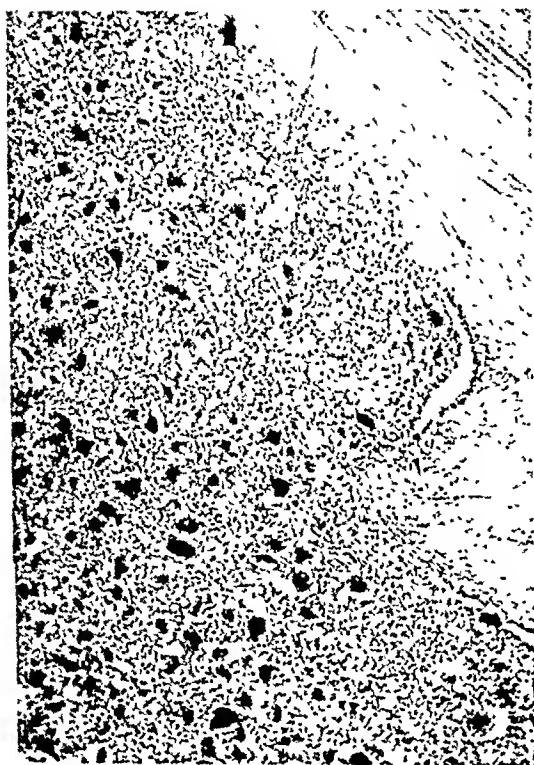


Fig. 49. Photomicrograph of a typical giant-cell tumor. There are over thirty giant cells to the low-power field and over fifteen nuclei to each giant cell. Note that in the stroma small round cells predominate.

trance of the nutrient vessel of a long bone. The upper femur and the upper humerus are most frequently affected, or a single vertebra may be involved (Fig. 54). Metastatic carcinoma is rare in bones below the elbow or the knee. The configuration of the tumor in the roentgenogram is that of an etched-out area in the medulla of the bone. A symmetrical central location is most frequent, and about this the cortical bone is thinned or destroyed, usually without much expansion. Pathologic fracture occurs in about 35 per cent of the cases. The roentgenogram of the chest is often an important diagnostic aid, since it may reveal other metastatic nodules in the lung (29).

istic picture is that of a central bone-destructive area occurring in the region of the en-

4. *Latent bone cysts.*—The latent bone cyst may occur at any age and is usually an accidental discovery in an adult who has had this quiescent lesion since childhood. Pathologically, it differs in no way from the juvenile bone cysts described previously in this paper, except that pathologic fracture is rarer and the bone shell about the cyst is thicker. The latent bone cyst of the adult is a more infrequent lesion than the bone cyst in youth, and constitutes less than 20 per cent

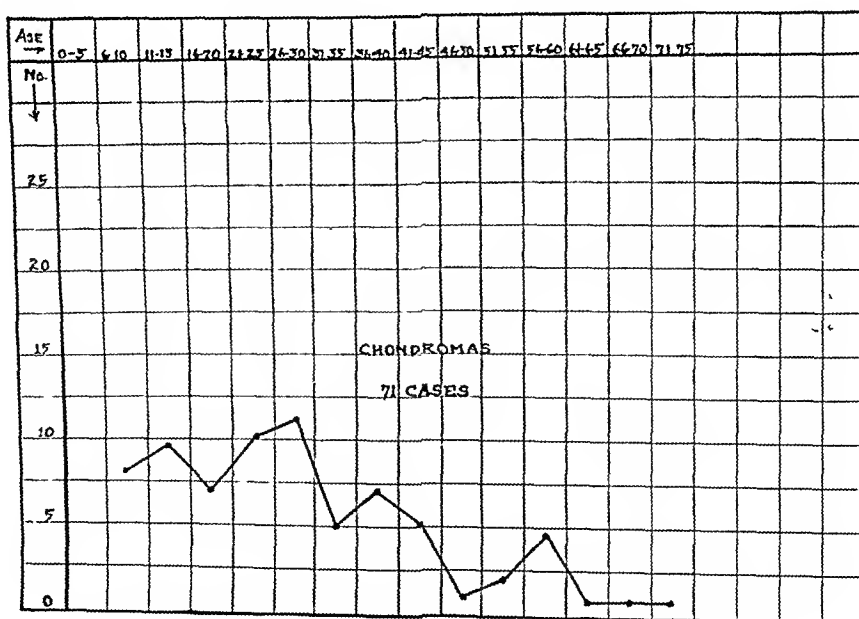


Fig. 50. Chart showing the age incidence of benign chondromas.

CHONDROMAS

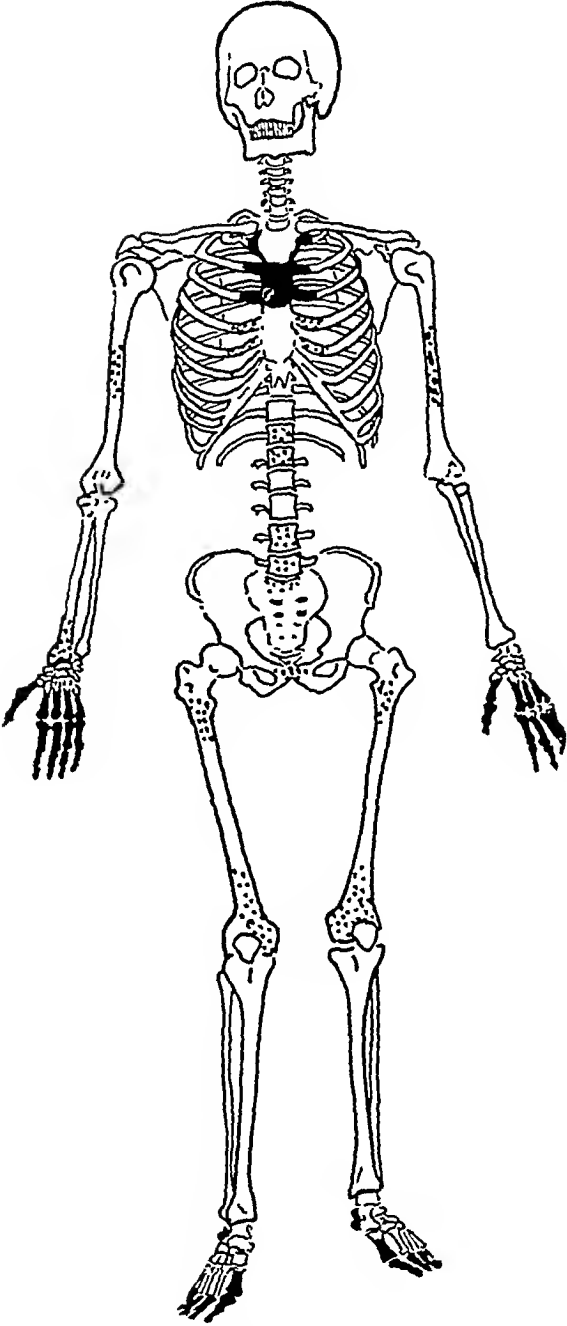


Fig. 51. Chart showing the incidence of benign chondromas according to skeletal location. The solid black areas indicate the most frequent sites and the dotted areas, the occasional sites.



Fig. 52. Photomicrograph taken from a 14-centimeter human embryo showing early joint formation. The joint spaces are formed by separation in the strands of pre-cartilaginous connective tissue, which may be seen in the photograph transversing the joint cavity as a dense band. The tibia and femur are shown, formed by early fetal cartilage cells.



Fig. 53-A. Roentgenographic appearance of a benign chondroma, situated in the phalanx of the forefinger. The chondroma is a central bone-destructive lesion and is composed of adult cartilage separated by strands of connective tissue.

of all bone cysts. Its persistence is due to Nature's difficulty in collapsing a cavity with rigid walls and is not to be ascribed to con-

tinued activity in the pathologic process, which has long since subsided in most instances. In the X-ray film the rarefied area is central, smooth, and definitely circumscribed by a bone shell which is thick and

—Multiple myeloma has never been recorded as a single lesion, but the onset of the disease clinically may be characterized by the involvement of a single area in one bone. Such rare instances have occurred



Fig. 53-B. Microscopic appearance of benign chondroma shown in Figure 53-A

competent. Owing to the long duration of its existence, it tends to be further from the metaphyseal region where bone cysts arise, because of its transport toward the mid-shaft region, coincident with the growth of the bone (Fig. 55). The bones affected are the same as those of the juvenile bone cyst, *viz.*, tibia, humerus, and femur. Slight bending of the bone in the affected area is often brought about by the structural weakness caused by the cyst. Treatment is rarely, if ever, indicated (30).

##### 5. *Multiple myeloma as a single lesion.*

twice among the twenty cases now recorded in the Surgical Pathological Laboratory (31), but from an analysis of all cases reported in the literature,<sup>8</sup> such an onset must be considered even more infrequent than this series would seem to indicate. When it has occurred the age incidence and location of the tumor as well as the configuration of the lesion on the X-ray film does not differ from a solitary form of metastatic carcinoma described above (Fig. 56).

<sup>8</sup>C. F. Geschickter and M. M. Copeland Arch. Surg. April, 1928, XVI, 807.



Fig. 54. Involvement of the humerus by solitary focus of metastatic hypernephroma. The X-ray film shows the central bone-destructive character of the lesion.



Fig. 55. Roentgenogram showing a latent bone cyst in the lower tibia in a man of 50. The tumor is of twenty-five years' duration and is well circumscribed by a thick shell of cortical bone. The lesion was completely healed and ossified three and one-half years after curetting.

The diagnosis in such a case may be aided by the finding of Bence-Jones bodies in the urine, but in the last analysis must depend upon biopsy and microscopic examination. A fuller consideration of multiple myeloma is given subsequently under Multiple Tumors of the Bone.

#### PART B

#### NEOPLASTIC ENTITIES OF BONE OCCURRING AS MULTIPLE LESIONS

Multiple tumors of bone are rarer than single lesions and occur about one-tenth as frequently as tumors of the solitary form. When multiple skeletal involvement does occur, the patient is more apt to be an adult than a child. This is because the largest group of multiple bone tumors is



Fig. 56. Roentgenogram of the femur in multiple myeloma, appearing clinically as a single lesion, in a white male, aged 45. There were no symptoms except pain and limping of two months' duration. The X-ray film shows a central area of bone destruction at the site of the nutrient vessel, with an intact shell of cortical bone. There is no periosteal reaction.

made up of metastatic carcinoma, multiple myeloma, and Paget's osteitis deformans, all three of which are practically restricted to patients over thirty-five and usually over fifty. Among youthful patients, multiple

### *I.—Multiple Osteoplastic Lesions Prevalent in Patients under Twenty*

Multiple bone-forming lesions in children are usually multiple cartilaginous exostoses.



Fig. 57. Roentgenogram of a child with hereditary deforming chondrodysplasia or multiple exostoses. Besides the multiple exostoses present, there is widening of the metaphyseal ends of the bones, curvature in the bones of forearms and legs, and deformities in the cortical zone at many points in the shaft

exostoses, disseminated osteomyelitis, multiple bone cysts, and fragile bones occur in the order of frequency given. These various types of multiple lesions of bone are discussed under the following chapter headings:

I Multiple Osteoplastic Lesions Prevalent in Patients under Twenty; II. Multiple Osteolytic Lesions Prevalent in Patients under Twenty; III. Multiple Osteoplastic Lesions Prevalent in Adults; IV. Multiple Osteolytic Lesions Prevalent in Adults.

These lesions resemble closely the single exostoses already discussed in Part A, Section I. Rarely, the osteoblastic form of osteogenic sarcoma may metastasize to other bones and thus give rise to multiple skeletal tumors of the most malignant sort; Ewing's sarcoma more frequently metastasizes to other bones, and may also be the cause of multiple skeletal involvement in patients under twenty: in either form of metastatic sarcoma, the diagnosis can be made on the basis of the original bone lesion, the char-





Fig 58 Roentgenogram illustrating the deformity and fusion of bones of the legs in a case of hereditary deforming chondrodysplasia



Fig 59-A. Roentgenograms illustrating osteosclerosis, or marble bones. Typical sclerosis of the metaphyseal and epiphyseal regions, affecting a child who had multiple fractures. Courtesy of Dr George G. Davis (35).

acteristics of which have already been described. A very unusual type of bone dystrophy may be present in juveniles and produce increased density in many bones. This is the so-called "marble bones," a variety of bone fragility known also as Albers-Schonberg's disease.

1. *Multiple exostoses (Chondrodysplasia)*—Multiple exostoses in children constitute a congenital, hereditary disease, which occurs about one-tenth as frequently as the single form. The hereditary factor is apparently direct or indirect, as in color blindness (transmitted by females to males). The disease is a congenital disturbance in the primitive perichondrium and hence affects markedly the growth of the bones. Not only do the tags of the perichondrium in the tendon ends proliferate to form the cartilaginous caps covering the bony out-

growths described under single exostoses, but disturbances and deficiencies in the periosteum in the metaphyseal regions lead to widening of the metaphysis and inhibiting of the bone growth. For this reason the X-ray films taken of this condition disclose numerous typical osteochondromas affecting the metaphyseal regions of the bones (Fig 57), and, in addition, widening of the metaphysis and variation in the length of the bones. The bones most frequently and severely affected are those of the forearm and leg. The membranous bones of the skull are not involved, but any of the other bones of the head or body may be distorted



Fig 59-B A rarer type of this disease affecting the small bones of the wrist in an otherwise normal adult.

by these growths. Most of the deformities occur in the cortex of the bone, which may be widened at irregular intervals along the entire shaft, giving a wavy outline, accentuated at points into plateaus of decreased density. Where two neighboring bones are affected, as in the radius and ulna, fusion may occur between these expanded and rarefied areas of the cortex (Fig. 58). Bending of the bones is frequent and occasionally central chondromas may be formed in the metaphysis by ingrowth of the cartilaginous areas which resemble bone cysts in the roentgenogram.

Such bone distortion, in association with multiple exostoses, makes the roentgenologic



Fig. 59-C. Roentgenogram of a case of scurvy showing the dense line just behind the epiphysis and the periosteal involvement, typical of this disease



Fig. 60 Roentgenogram showing a bone dystrophy in a white male, aged seven, in which there is new bone formation restricted to the diaphyseal regions. The new bone formation also involves the skull, occluding various foramina. This is an unclassified form of juvenile bone dystrophy.



Figs 61-A and 61-B Roentgenograms of a case of osteomyelitis in a young child, which originated in the bones of the pelvis and metastasized to the bones in the forearm. Note the numerous small punched-out areas in the metastatic foci.

diagnosis extremely easy. A familial history of the early onset of the disease in a youthful patient, with stunted growth, is reaffirming evidence.

The prognosis for life in these cases is good, but there is no adequate form of treatment except operation for correction of deformities after the growth period has ceased. In two cases we have observed secondary malignant change in these cartilaginous growths, resulting in death from chondromyxosarcoma (32, 33).

2. *Marble bones*—This appears to be the rarest form and the most recently recognized of the group of cases in the bone fragility class. It is essentially a disease of children, although Reiche (34) described a case in a man aged 37. The usual age is between twelve and twenty years. Clinically, these patients come under observation be-

cause of pathologic fracture, or abnormalities in the cranium. The sella turcica may be small, and narrowing of the cranial foramina, with consequent optic atrophy, may occur. The teeth are usually decayed and poorly formed. Calcification about the ligaments has been described, with occasional premature calcification of the vessels. The roentgenogram of the bones is characteristic. The metaphyses and epiphyses of the long bones are sclerosed by increased calcification (Figs. 59-A and 59-B), while the small bones of the hands and feet and the vertebræ show a definitely increased compactness originating in similar zones. Pathologic fractures are frequent. Characteristic transverse rings of calcification at the ends of the long bones have been referred to in the literature as a diagnostic feature. The children affected are gen-

erally poorly nourished and are apt to die of intercurrent infections (35).

3. *Infantile scurvy*.—Infantile scurvy is a deficiency disease due to a lack of Vitamin water-soluble C. It is identical in its essentials with the scurvy found in adults, but the infantile form has a more acute onset and the character of the bony changes is influenced by the undeveloped state of the affected bones. This type of scurvy begins most frequently between the sixth and tenth months of life and reaches an acute stage in two or three months. In children thus affected, motion is extremely painful and there is a pseudoparalysis because of the immobile state in which the limbs are held. Hemorrhages in the neighborhood of the bone are an outstanding characteristic of the disease. The most severe of these occur beneath the periosteum and about the teeth, but they also occur in the muscle substance near the bone, or subcutaneously, and hematuria is often present. The swelling about the epiphyseal line and about the joints, the extreme pain on pressure in these regions, subcutaneous hemorrhages, and the purple bleeding gums form a typical clinical picture.

In the X-ray film (Fig. 59-C) there is, behind the epiphyseal line, a marked increase in the density of calcification, described as "the white line." There is also a widening of the distance between the shaft and the epiphysis and the small epiphysis may have a characteristic ring about its edge. Subperiosteal hemorrhages followed by a slight amount of new bone formation are seen in advanced cases but may be slight and easily overlooked in an early stage. If the disease has not progressed too far, it yields promptly to a diet of fresh whole milk and orange juice.

*Summary of multiple osteoplastic lesions in children*.—Multiple osteoplastic lesions are not difficult to diagnose when occurring in the young. The most frequent multiple tumor met with is the congenital cartilag-



Fig. 62-A. Roentgenogram of the complete skeleton of a still-born child with osteogenesis imperfecta. From Knaggs' "Diseases of Bone," William Wood & Company, N. Y., 1926, page 376

inous exostosis, which can be readily diagnosed by the typical outgrowths in the cortical zone, the variation in length of the bones of the skeleton, and the metaphyseal widening. The hereditary history which can usually be obtained clinches the diagnosis. Marble bone is a rare condition and should be recognized by the series of calcified rings, sclerosing the epiphyseal and metaphyseal regions. Ewing's sarcoma, with skeletal metastases, can be diagnosed from the character of the lesion in the bone first affected. Rarely in a child under ten there will be forms of bone dystrophy accompanied by diffuse ossifying periostitis affecting the shafts but not the epiphyses of all of the long bones. Similar ossification in the skull will lead to optic atrophy and deafness by encroachment on the foramina of the cranial nerves. The X-ray films of such a case are shown in Figure



Fig. 62-B. Roentgenogram of a case of rickets showing the saucer-like changes at the epiphyseal line.

60. No adequate diagnosis can be made of such conditions, nor is the ultimate outcome predictable.

## II.—Multiple Osteolytic Lesions Prevalent in Patients under Twenty

Multiple osteolytic lesions in children are usually benign. Metastatic osteomyelitis, with multiple bone involvement, is perhaps the most frequent form of this group of lesions. Bone cysts, usually containing giant-cell areas, may occur in several bones of the same patient, but there is always some complicating skeletal disease, such as congenital syphilis or fragilitas ossium. The latter type of disease, known often as osteopsathyrosis, occurs in several well-recognized forms.

1. *Metastatic osteomyelitis*.—While acute osteomyelitis in a child usually involves a single bone, several bones in the same patient are affected in about 15 per cent of the cases. When multiplicity occurs, an interval of time varying from days

to weeks in duration may elapse between the primary infection in the first bone and the involvement of other areas of the skeleton. The development of these secondary foci is usually marked by chills and fever and the bones last involved are not so severely affected. The stage of necrosis may not be reached and swelling only, with or without pus formation, may occur. If many bones are successively involved, internal abscesses and fatal septicemia are apt to follow. Trendelenburg (36) found that in 1,058 cases of acute osteomyelitis, 166 had multiple bone involvement, the usual case having two or three bones affected. In only 13 cases were from four to ten bones involved. In one-third of the multiple cases, the short or flat bones were involved along with the long bones.

In the X-ray film the usual source of confusion is the involvement of the flat bones, which may show one or more eaten-out areas which in themselves are not diagnostic and which can be interpreted only when studied together with the other bone involvement and the clinical history. These punched-out, necrotic areas may occur in the ends of the long bones of children (Figs. 61-A and 61-B), but are more often seen in the ilium or scapula.

2. *Bone fragility*.—Idiopathic bone fragility has been described in numerous forms and under a group of conflicting terms. Among the German authors many of these lesions have been grouped together, under the term of idiopathic osteopsathyrosis, comprising several well-recognized varieties, including:

- (a) *Osteogenesis imperfecta*, a non-hereditary disease, with multiple fractures; present at birth; the infants usually die.
- (b) *Fragilitas ossium*, an hereditary form, accompanied by such features as brittle bones, blue sclerae, deafness, and loose joints, also a proneness to pathologic fracture.

(c) Marble bones, or Albers-Schönberg disease, already discussed, which is characterized by dense lime rings in the metaphyseal and epiphyseal regions of the long bones, pathologic fracture.

secure and does not lend itself to classification. In the brief descriptions given below we have chosen two forms in which rarefaction of the bones occurs.

*Osteogenesis imperfecta:* In outspoken



Fig. 63-A. Roentgenogram illustrating fracture deformities in a case of fragilitas ossium showing very well the bloated and expanded ends of the bone, which are unusually broad and foamy in appearance. The fracture in the splinted leg has occurred through a cystic area.

and excessive calcification in peri-articular structures.

Information at the present time is not sufficient to permit of a rigid separation of these various forms of bone fragility, although in well-defined cases it is often easy to classify the condition under one of the three heads given above. More often the exact nature of the osseous change is ob-

scure and does not lend itself to classification. In cases of osteogenesis imperfecta, the children are either still-born or survive only a short time. The skeleton is riddled by truly spontaneous fractures of the extremities and ribs, with consequent deformity and shortening. The ossification in the skull is usually very incomplete. Typical cases have been cited by Knaggs (37) in "Diseases of Bone" (Fig. 62-A). In cases that survive in-

fancy and reach childhood (varying in age between eight and twelve years), marked bending of the bones may occur, with development of cystic areas in the metaphyseal regions, roentgenologically not unlike

present, which helps to distinguish this group from "marble bones," in which gradual occlusion of the foramina in the skull occurs.

In the X-ray films the bones have a



Fig. 63-B. Shows a pronounced coxa vara, with multiple fractures about the necks of both femurs. Same case as shown in Figure 63-A.

the solitary or multiple bone cysts described elsewhere. The numerous fractures may heal but the deformity continues and non-union at one or more sites is the rule.

*Fragilitas ossium:* *Fragilitas ossium*, which is more frequent between the ages of eight and sixteen, at the time of clinical recognition is probably best represented by the well defined group referred to as "brittle bones" and "blue scleræ." This disease is practically always of the hereditary type, being transmitted from parents to children in a direct fashion. The outstanding clinical characteristics are the fragility of the bones, with accompanying fractures and deformities, the blue color of the scleræ, and deafness, which is generally of the otosclerotic type. Optic atrophy is not usually

characteristically thin cortex, except where repeated fractures have stimulated increased ossification. The shafts of the long bones are more slender than normal, whereas the ends, including the metaphyses and epiphyses, are unusually broad and foamy in appearance. Slight bowing is present in most of the long bones, which may be markedly increased by fractures and mal-union. Key (38) reports 70 per cent of fractures in the cases reviewed by him (Figs. 63-A and 63-B).

*Rickets.*—Rickets is a nutritional disturbance affecting the calcium and phosphorus balance and leading to marked bony changes, found in children suffering from a deficiency in Vitamin fat-soluble A. While there are a few scattered cases of late rickets in pa-

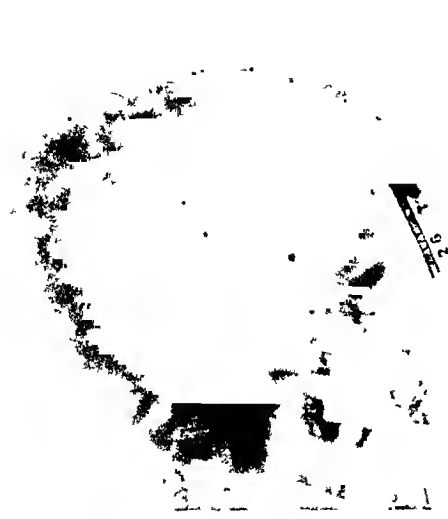


Fig. 64-A. A case of Paget's osteitis deformans involving the skull, pelvis, femora, and tibiae. Note the widening and roughening of the tables of the skull, spoken of as of "nigger wool" appearance.

tients between the ages of twelve and twenty, the usual age of onset varies between one and three years of age. The leading deformities in the skeleton are bending of the long bones, beading of the ribs at the costo-chondral junction, cranial tabes (undeveloped patches in the skull bones), with skull deformity, stunting of growth, and pathologic fracture. If the disease begins before the age when the normal child learns to walk, the patient is delayed in learning this function. There is usually under-nutrition, irritability, lowered resistance, and a marked susceptibility to pneumonia (Fig. 62-B).

In the X-ray film the most diagnostic feature is a "saucer-shaped" epiphyseal line, which is widened and extremely irregular, with bone absorption or decalcification occurring on either side of it. Atrophy in the ends of the bone may be marked, and if the child has walked, bowing of the tibia may be extreme. The sternal ends of the ribs show widening or fracture, and similar deformities. The spine shows a single long posterior curve from the cervical region

R



Fig. 64-B. Shows a characteristic anterior bowing of the tibia. Same case as shown in Figure 64-A.

downward, with a compensating anterior curve in the neck. The pelvis is deformed either by flattening in the antero-posterior diameter, or by funnelling due to the pressure of the femurs upward. The skull has a squared appearance, flat on top and long in its parietal direction.

The treatment is specific. It should aim at introducing the factor of fat-soluble Vitamin A (sunlight and cod liver oil) and securing the proper grade of milk for the child.

*Summary of multiple osteolytic lesions in children.*—The differential diagnosis in



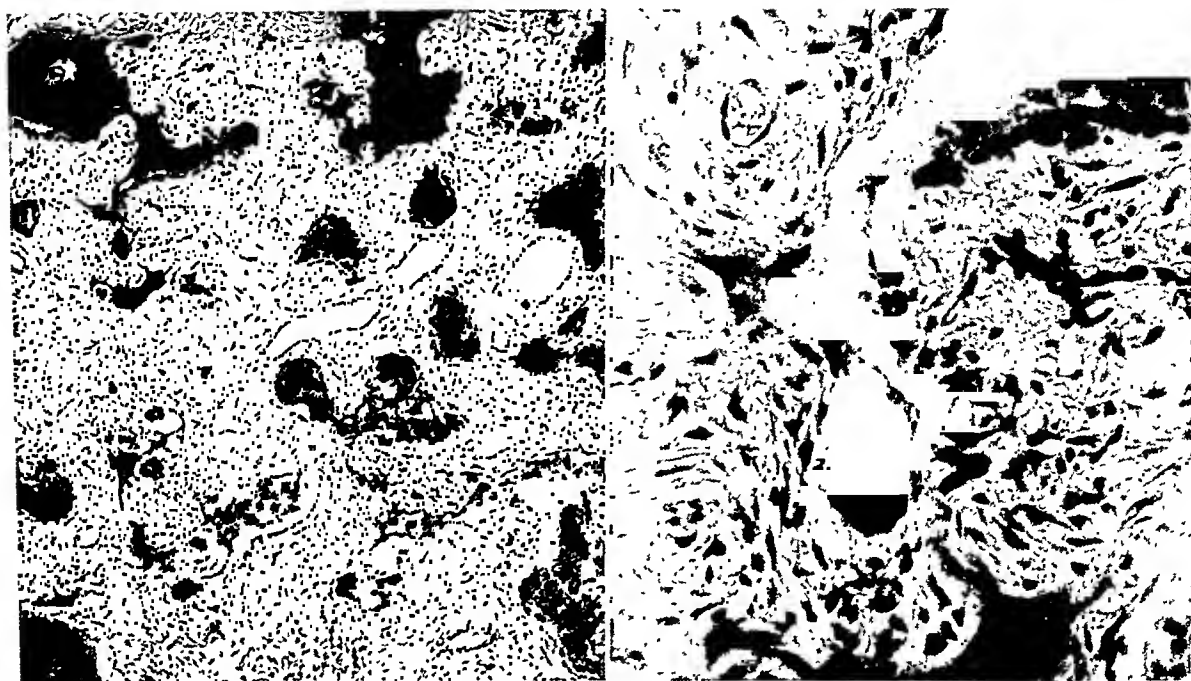


Fig. 65. Photomicrographs showing the pathologic changes in Paget's osteitis. The spicules of new bone can be seen undergoing secondary resorption through the activity of giant-cell osteoclasts. Both low and high magnifications are shown.

multiple osteolytic lesions in children is not difficult. Multiple osteomyelitis usually shows at least one bone affected in a characteristic manner, with irregular bone destruction and new bone formation. The lesions, although multiple, are focal and not diffuse. In bone fragility, there is a diffuse involvement, the shafts of the bones being abnormally slender and the ends widened, and often cystic. Pathologic fracture is the rule in bone fragility, but practically never occurs (under 2 per cent) in osteomyelitis. The difficulty in the bone fragility group of cases is not in the recognition of the presence of the dystrophy, but in the classification of this group of cases on the basis of inadequate present-day knowledge. In the very young, cases with multiple fractures are usually due to osteogenesis imperfecta. In a child just before puberty, with a characteristic familial history and blue scleræ, the case is safely classed as one of brittle bones. Other less well-recognized cases are perhaps

best left unclassified and described in detail as independent forms of bone dystrophy.

### *III.—Multiple Osteoplastic Lesions in the Adult*

The usual bone-forming tumor showing multiple skeletal involvement in the adult is Paget's osteitis deformans. This disease, which in all probability is not of neoplastic nature, may be closely simulated by multiple metastatic carcinoma. While surgical intervention is not necessary in either case, it is important to make the distinction in the diagnosis, because of the difference in prognosis. Paget's disease in the skeleton runs a benign and protracted course and unless sarcoma of the bone arises as a secondary change (approximately 5 per cent), the life of the patient is not materially affected. On the other hand, metastatic carcinoma is always a hopeless disease.

*Osteitis deformans.*—Paget's disease of

the skeleton affects primarily male adults, usually past the age of forty-five. The bone involvement is most often multiple, affecting the tibiae, skull, and the pelvis, in the order of frequency given. The femurs are

wool." The bones of the calvarium are thickened from two to five times their normal extent and are made up of areas of varying density, with a very fuzzy inner and outer table. The tibiae are bowed, and the

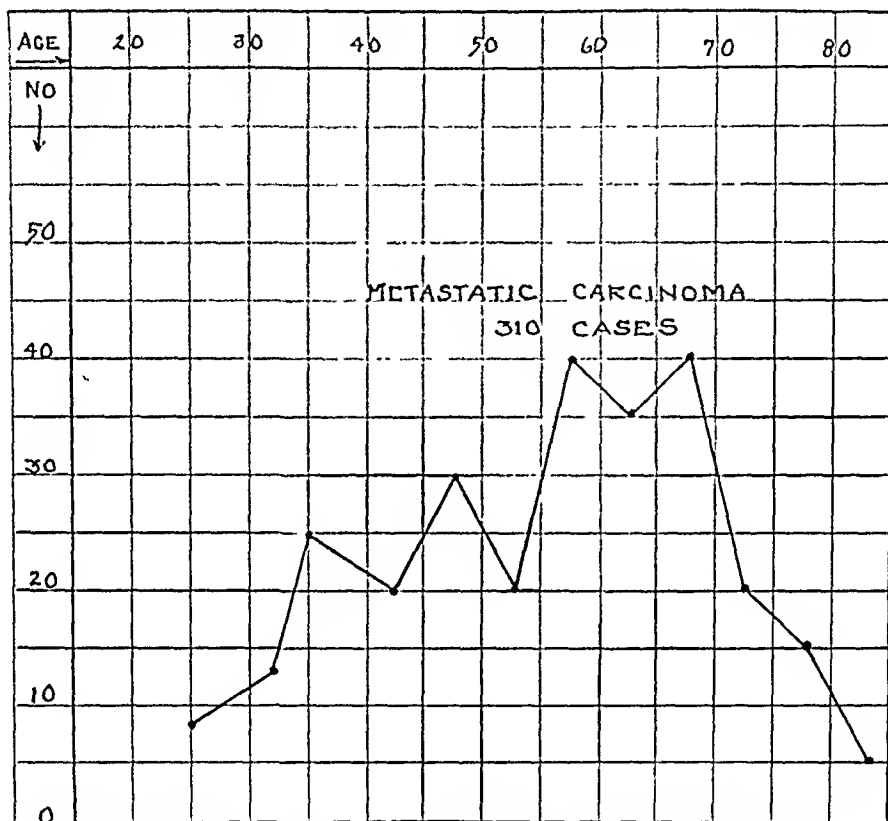


Fig. 66-A. Chart showing age incidence of metastatic carcinoma of bone.

also prone to involvement. When the disease occurs as a single lesion, the tibia is most usually affected. When it is generalized, the spine is sooner or later involved. The clinical appearance of the patient in an advanced case is characteristic. The skull is enlarged and squared across the front; the tibiae are bowed forward, and the femora bent laterally; the pelvis is widened and a gradual lordosis affects the spine; varicose veins are present in the lower extremities, and tortuous sclerotic arteries are frequent.

In the X-ray film the characteristic appearance of the skull is described as "nigger

cortex added to by new bone formation of decreased density in the subperiosteal zone. Cyst formation may occur beneath the cortex and most commonly is located in these bones of the leg (Figs. 64-A and 64-B). The pelvis and femora, when involved, present similar pictures to the tibiae. The bones are widened by new bone of decreased density, but cysts are less frequent in these regions.

Histologically, the basis of the disease is bone absorption replaced by ossification of a low order. Under the microscope giant-cell osteoclasts may be seen destroying old spicules of laminated bone, while at the

## METASTATIC CARCINOMA

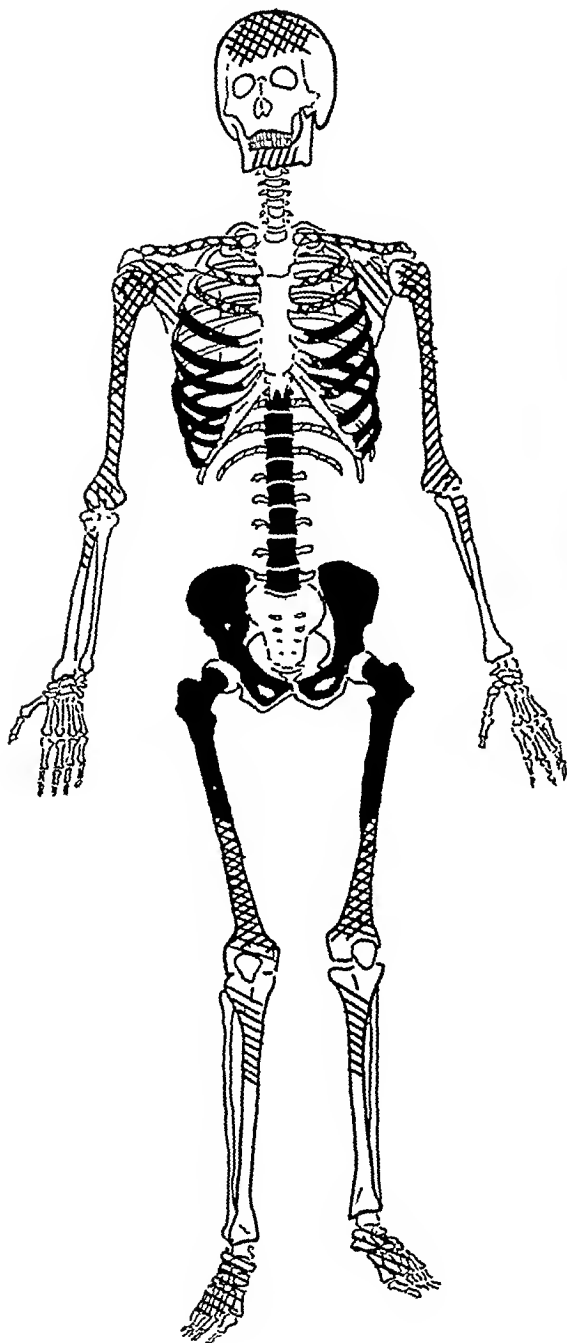


Fig. 66-B. Chart showing the skeletal distribution of metastatic carcinoma of bone. The solid black areas indicate the most frequent sites; the checked areas, the common sites; the diagonal line areas, the occasional sites

same time there is an increase of young loose connective tissue, permeated by many young capillaries, with the formation of

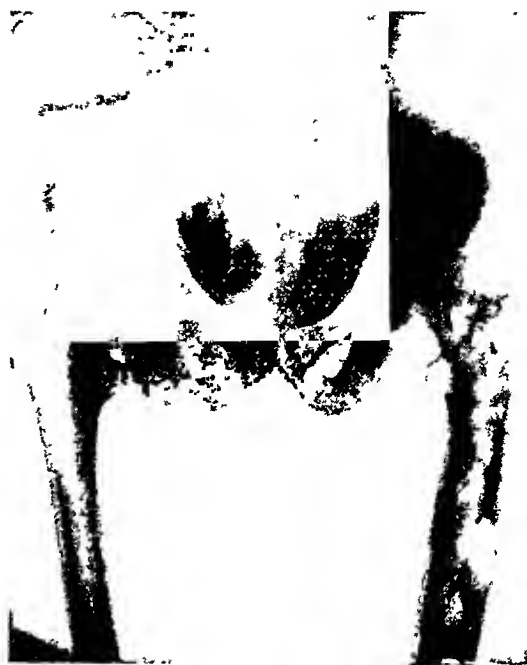


Fig. 67-A. Roentgenogram of multiple areas of bone destruction due to metastatic carcinoma. Note that the areas of bone destruction are discrete but overlapping like the links of a chain.

new coarse membranous bone (Fig. 65). This new coarse bone replacing the old denser bone leads to an enlargement and elongation of the bones, accompanied by bending. Pathologic fracture occurs, but is not frequent and has been recorded in only isolated cases.

One of the important complications of Paget's osteitis deformans is its association with a malignant disease. Sir James Paget (39), who originally described this disease in 1876, was struck by the frequency with which malignancy occurred in the cases which he reported. Carcinoma associated with this disease is probably accidental, and, without doubt, in some cases recorded the entire skeletal changes have been due, not to Paget's disease but to metastatic carcinoma. The simulation of this form of metastatic carcinoma to Paget's disease is due to the fact that the metastases are *via* the lymphatics and hence affect the subperiosteal zone, bringing about new bone formation.

It is this same subperiosteal zone which is also the seat of new bone formation in osteitis deformans.

On the X-ray film the differential diagnosis can usually be made because metastatic

### *Multiple Osteolytic Tumors in the Adult*

1. *Metastatic carcinoma.*—Metastatic carcinoma of bone gives an extremely variable picture, since it may be either a mul-



Fig. 67-B. Areas of metastatic bone destruction which are confluent and show a continuous zone of resorption extending from the acetabular cavity across the ilium to the sacrum.

carcinoma, despite the new bone formation about the lymphatic zone, always produces lytic changes in the medullary cavity, whereas this is not the rule in Paget's disease. Involvement and bowing of the tibiae are common in Paget's disease, but rare in metastatic carcinoma, while lung metastases are absent in Paget's but occur in carcinoma.

In from 5 to 7 per cent of the cases of Paget's disease, malignancy in the form of sarcomatous change takes place in the bones affected (40). This form of sarcoma is generally periosteal in type, and may be either of the chondral or osteoblastic variety of osteogenic sarcoma.

multiple or single lesion of the skeleton and either osteolytic or osteoplastic. Nearly one-half of the lesions occur as a single focus in the end of a long bone in an adult at the point of entrance of a nutrient vessel, and produce a central area of bone destruction without much expansion of the cortex. An equal number of lesions of the metastatic type produce a diffuse multiple involvement, most frequent in the spine, pelvis, skull, and the upper ends of the long bones at the pelvic and shoulder girdles. The usual age distribution ranges from forty to eighty and is maximal at fifty-five. The bones which are most frequently affected are those of



Fig. 68-A. Diffuse involvement of the skeleton by metastatic carcinoma in which bone destruction is counterbalanced by new bone formation.



Fig. 68-B. Same case as shown in Figure 68-A (which see).

the spine, pelvis, the femurs, and the ribs (Figs. 66-A and 66-B).

The source of these tumors is variable. The secondary tumors in the bone are usually the result of a primary carcinoma in the prostate or breast, a hypernephroma in the kidney, or malignancy in the thyroid or gastro-intestinal tract. The following list is representative, and is a tabulation from the records of cases on file in the Surgical Pathological Laboratory:

|  |            |
|--|------------|
| Metastatic from prostate.....                | 134        |
| Metastatic from breast.....                  | 100        |
| Metastatic hypernephroma.....                | 22         |
| Metastatic from gastro-intestinal tract..... | 11         |
| Metastatic from female genitalia.....        | 7          |
| Metastatic from thyroid.....                 | 6          |
| Metastatic from skin.....                    | 5          |
| Metastatic from lung.....                    | 4          |
| Metastatic from biliary tract.....           | 3          |
| Metastatic from nasopharynx.....             | 2          |
| Metastatic from bladder.....                 | 1          |
| Metastatic from chest wall.....              | 1          |
| Metastatic from neck.....                    | 1          |
| Metastatic from testicle.....                | 1          |
| Undetermined source.....                     | 36         |
| <b>Total .....</b>                           | <b>334</b> |

Clinically, pain of a severe rheumatic character is an important feature. When

these metastatic foci localize about the spine, girdle pains and neurologic manifestations may occur. A pathologic fracture, which occurs in one-third of the cases, is often the initial symptom. From a diagnostic standpoint the knowledge or discovery of the primary tumor elsewhere in the body is most important.

The roentgenologic features of these tumors depend primarily upon whether the disease has a single focus or multiple foci, and upon whether the malignant growth is transported to the bone by a medullary route *via* the nutrient vessel or by a periosteal route *via* the lymphatics and periosteal blood vessels. If the metastases occur by the medullary route, the result is a central bone-destructive lesion and most of such lesions localize in but a single bone. If the metastases occur by the lymphatic route, new bone formation is more often stimulated and diffuse osteoplastic involvement of numerous bones, along with areas of bone necrosis, is the result.

The solitary central metastatic lesions in bone have already been discussed.

When metastatic carcinoma to bone results in a diffuse multiple involvement, the extremities about the shoulder and pelvic girdles are usually involved in association with the spine, the pelvis, and the skull. In the extremities the region near the pelvic girdle is more frequently involved than the humeri and scapulæ, and in the trunk the spine is more frequently involved than the ribs and sternum. The bones below the elbow have been involved only twice in this series of 334 cases, and the bones below the knee, including the feet, have been involved in six instances.

When the diffuse involvement is osteolytic in character the areas of destruction range from small punched-out areas, which may overlap each other like a series of rings in a chain, to large areas of destruction, which may produce bending and collapse of the bone, with pathologic fracture (Figs. 67-*A* and 67-*B*). Metastatic carcinoma from the breast is one of the most frequent forms of neoplasm in this group, giving rise to such diffuse osteolytic involvement. In the X-ray film there are usually areas of new bone formation, associated with areas of destruction, which fact aids in distinguishing these lesions from multiple myeloma, the latter producing multiple punched-out areas—usually smaller, more prone to involve the spine and ribs, associated with Bence-Jones bodies in the urine, and not showing a primary disease focus outside of the skeleton.

When the diffuse involvement is osteoplastic the bones involved usually show a combination of new bone formation and bone destruction, resulting in a widening of the bone and a decrease in bone density (Figs. 68-*A* and 68-*B*). The new bone formation gives an irregular and fuzzy appearance to the periosteal region of the bones affected. Metastatic carcinoma of the prostate is the most frequent type of lesion in

this group giving rise to such osteoplastic metastases. Apparently the reason for this osteoplastic reaction in the bone is the fact that the metastases reach the skeleton through the periosteal vessels, which are identical in location with the osteogenetic regions of the bone. Metastases deposited in these regions, therefore, act as stimuli to new bone production.

The pathology of metastatic carcinoma varies according to the nature of the primary tumor. There is no proved reason that will account for the tendency of these tumors to become secondarily located in the skeleton, nor is there any adequate knowledge of the exact mode by which these growths reach the bone, although we have tried to give by inference our own interpretation for the occurrence of osteolytic lesions in one group of cases and osteoplastic lesions in another.

Metastatic carcinoma is usually a hopeless disease, but much palliative relief can be achieved by irradiation with the X-rays or with radium. We have on record instances where even metastatic melanotic carcinoma to bone has been held in check for a period of over six years, so that there is no need for the physician in charge of the case to treat it from an utterly hopeless point of view. In general, not only symptomatic relief, but actual prolongation of life—a matter of months and, rarely, of years—may be achieved by competent irradiation (41, 42).

2. *Multiple myeloma*.—Multiple myeloma is one of the rarest and most malignant diseases of bone. The occurrence in males is twice as frequent as in females and the age distribution resembles that of metastatic carcinoma (Figs. 69-*A* and 69-*B*), the peak of the age incidence being at fifty-five. In 425 cases reported in the literature, only two instances of this disease in patients under thirty have been recorded, one at twenty-two and one at twenty-seven. Multiple myeloma rarely presents itself

clinically as a single lesion, but is always multiple before the determination of the disease. The tumor area is always one of central bone necrosis. The six cardinal diagnostic features as described in a pre-

fied osteoporotic appearance, and in such cases, although the areas of rarefaction are generally smaller, the X-ray appearance cannot always be distinguished clinically from metastatic carcinoma. One helpful point is

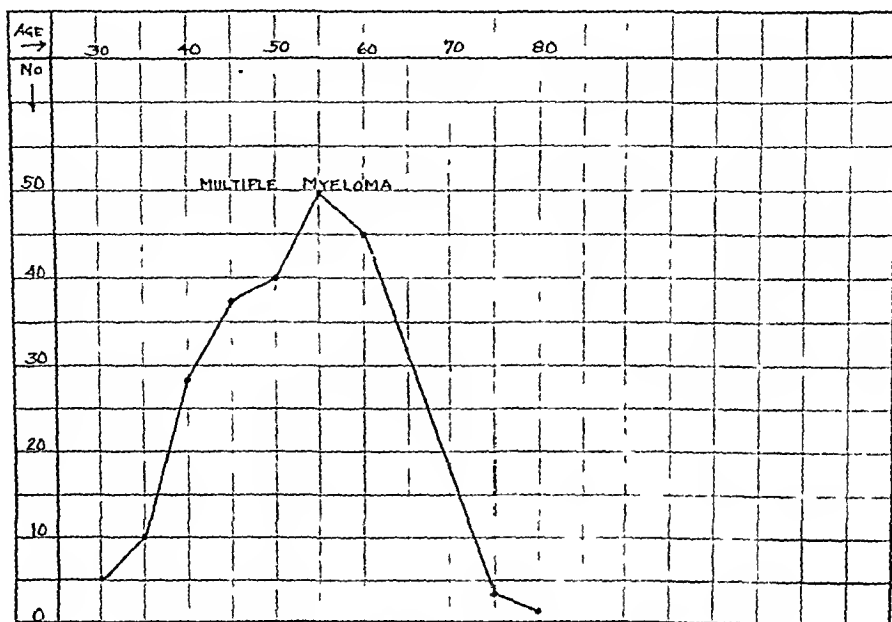


Fig. 69-A Chart showing age incidence of multiple myeloma.

vious communication by the author are: (1) multiple involvement of the skeletal trunk by tumor formation in an adult over thirty-five years of age; (2) pathologic fracture of a rib; (3) the presence of Bence-Jones bodies in the urine; (4) lumbar backache with signs of early paraplegia; (5) an otherwise inexplicable anemia, and (6) a chronic nephrosis, with nitrogen retention and low blood pressure.

The typical X-ray appearance is that of multiple punched-out areas accompanied by deformity and pathologic fracture (Figs. 70-A, 70-B, 70-C): the latter occurs in 62 per cent of all cases. The usual involvement is in the skeletal trunk, but the skull as well as the long pipe bones about the shoulder and pelvic girdle are often affected. Diffuse involvement gives the bones a rare-

that multiple myeloma rarely shows chest metastasis, while this is quite frequently found in cases of metastatic carcinoma. In the skull the multiple punched-out areas are usually in the frontal and upper parietal regions. In the trunk, the spine is affected by infraction and globular areas of bone destruction, while the ribs are frequently mottled and fractured. The pelvis may become diffusely mottled and bloated in appearance. Involvement of the bones beyond the knee or elbow is rare. The microscopic picture, which is characteristic and usually of the plasma-cell type, is the last resort in diagnosis. Histogenetically, the disease originates in the bone marrow, but may metastasize to the lymph nodes, liver, and spleen (Fig. 71) (43, 44).

3. *Osteomalacia and von Recklinghausen's*

## MULTIPLE MYELOMA

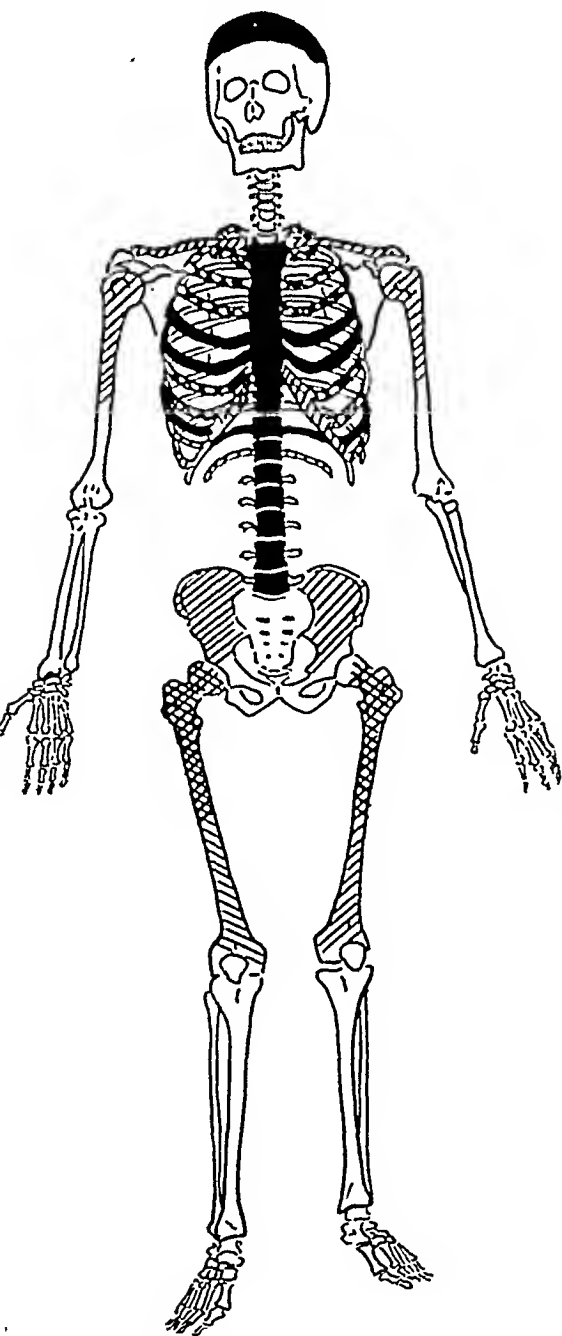


Fig. 69-B. Chart showing skeletal distribution of multiple myeloma. The solid black areas indicate the most frequent sites; the checked areas, the common sites; the diagonal line areas, the occasional sites.

*disease.*—A disturbance in the lime salt content of the bones leading to softening and consequent bending and deformity in an adult is referred to as osteomalacia. If the



Fig. 70-A. Roentgenogram of the skull in multiple myeloma, showing the multiple punched-out areas in the frontal and parietal bones.



Fig. 70-B Shows the involvement of the lumbar spine (same case).

condition is associated with pregnancy in women between twenty and forty, the diagnosis is usually accepted as confirmed, but if male adults or women past the menopause are affected and multiple cysts are also present in the bones, the case is more apt to be



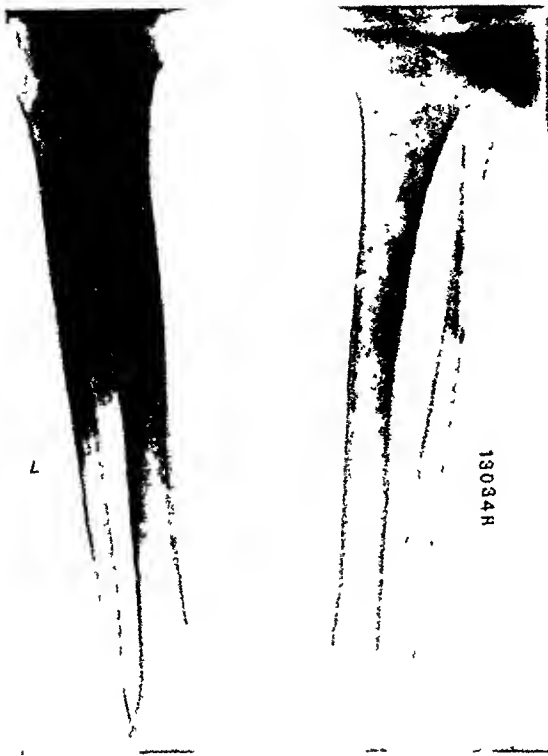


Fig. 70-C. Shows the classical punched-out areas of the tibiae and fibulae (same case).

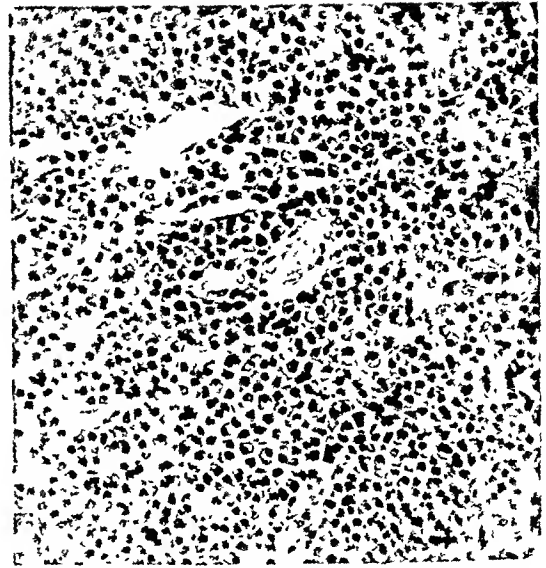


Fig. 71. Photomicrograph of the plasma cell type of multiple myeloma.

classed as von Recklinghausen's generalized osteitis fibrosa. Since solitary bone cysts need not be associated with such generalized skeletal deformities and since multiple bone cysts may occur in various types of skeletal diseases, such as Paget's osteitis deformans, fragilitas ossium, congenital syphilis, and in patients afflicted with parathyroid tumor, the description of von Recklinghausen's disease as a separate entity leads only to confusion. The cysts themselves are usually the same as those of the solitary form and their multiplicity is best attributed to the factor of the associated disease rather than to some unique and separate entity.

Multiple cysts of the bones are probably associated most frequently with osteomalacia. Although this condition is most easily recognizable in women in the child-bearing age, the senile form occurs in both males and females after the age of sixty. Improvement is apt to follow the menopause

in women affected during pregnancy. In progressive stages of the disease, however, pain increases with the deformities, and disability is often severe enough to keep the patient bedridden.

In the X-ray film the most characteristic appearances are the deformities which affect the thorax, pelvis, and the long bones. Compression of the pelvis is due to the weight transmitted through the femurs upward and from the spine downward. In accordance with this, the sides of the pelvis are pushed inward and the sacrum forward and downward.

In the long bones the deformities generally follow fracture and healing. The layers of compact bone are gradually absorbed until the cortex is paper-like in thinness and the entire bone is coarse, cancellous, and nearly transparent. Cysts of the osteitis fibrosa type occur in the marrow cavity, increasing the deformity and the liability to fracture. The cysts are prone to progress along the shaft of the long bones until nearly one-half of the length is involved. At times, spontaneous regression and healing take place, and we have seen such large evacuated

areas in the skull disappear without treatment (45, 46).

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## LESIONS OF THE CLAVICLE

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THE clavicle is classified as one of the smaller bones of the skeletal framework and is very seldom heard of in tumor pathology. However, under a systematic review of the skeletal lesions on file in the Surgical Pathological Laboratory of the Johns Hopkins Medical School, we find that there are lesions of all kinds present in the clavicle as elsewhere in other bones.

As for the anatomy of the clavicle, it is well to recall the peculiar S-shape of the bone which articulates with the sternum and the acromion process of the scapula, forming the mainstay of the shoulder girdle. The sternal end articulates with the sternum by means of the intervention of fibro-cartilaginous discs, while the acromial end articulates directly. The structure of the clavicle is peculiar in that it is made up entirely of cancellous bone with a dense cortical covering, there being no medullary cavity. The ossification in this bone is also of interest as it is the first bone in the body to show signs of ossification and the last to become ossified, since the secondary ossification which is located at the sternal end does not join the main body until after the twenty-fifth year. Whether these peculiarities have any importance may be seen in the following discussion.

Lesions of the clavicle are easily recognized but difficult to diagnose and to treat correctly. The clavicle is a superficial bone and may be palpated easily over its whole course, any abnormality being easily recognized by the evident deformity produced. Fractured clavicles are easily picked out by the deformity due to displacement of fractured ends of the bones and by the characteristic drooping of the shoulder. Any abnormal swellings are easily seen; however,

the X-ray appearance is very vague and often confusing, due to the interference of the chest structures and numerous other bones in close proximity. Well-defined and clear films are not easily obtained. Also, in regard to common diseases such as syphilis, gonorrheal arthritis, and cartilaginous tumors, which are so frequently found in the region of the sternal joint, the X-ray appearance is very indefinite, and in this site a most careful history should be taken concerning venereal diseases. One such case completely baffled a well-known clinic until anti-syphilitic treatment was recommended on the basis of a syphilitic history and ultimately the tumor disappeared. Biopsy in this region is of value, but, again, biopsy should not be resorted to without preparation for radical treatment, and radical treatment in the region of the clavicle is a rather mutilating and serious operation.

In the study presented here we find that of 1,700 bone lesions on record in the Laboratory there were 41 lesions located in the clavicle. They are recorded and classified as follows:

TABLE I

| Type of lesion       | Total skeletal lesions | Clavicular lesions |
|----------------------|------------------------|--------------------|
| Periostitis          | 100                    | 7                  |
| Exostosis            | 262                    | 2                  |
| Chondroma            | 75                     | 1                  |
| Bone cyst            | 175                    | 4                  |
| Giant-cell tumor     | 226                    | 1                  |
| Chondroblastoma      | 21                     | 1                  |
| Osteogenic sarcoma   | 170                    | 1                  |
| Sclerosing sarcoma   | 80                     | 1                  |
| Ewing's sarcoma      | 70                     | 4                  |
| Multiple myeloma     | 20                     | 8                  |
| Metastatic carcinoma | 310                    | 16                 |

In the discussion of these tumors in the order as recorded above, we shall take into consideration the clinical picture, X-ray

findings, treatment, and results as far as it has been possible to obtain them.

#### NON-SUPPURATIVE PERIOSTITIS

This type of lesion showed in our series seven cases, or 7 per cent of the total number of similar lesions found in other bones and discussed thoroughly by Dr. L. C. Cohn from the same laboratory. Five of the seven cases were found in females. One of the seven cases was of a multiple type. The duration of symptoms averaged from six to forty-eight months. Three patients of the group gave a history of tumor, while four gave a history of pain localized in the bone and associated with swelling. Five patients gave a syphilitic history, while only one had the etiology of trauma. The X-ray film showed both bone destruction and sclerosis in most instances, while in two it showed sclerosis or destruction alone. This goes to prove that the X-ray findings are rather variable and may lead to a confused diagnosis. According to the follow-up notes, the five cases with syphilitic history were given anti-syphilitic treatment and three cases were reported as cured ranging over a period of from two to eleven years. One of these cases had a biopsy performed, and microscopical examination revealed only an infected granulation tissue.

#### EXOSTOSIS

According to its definition this is a bony growth projecting out from the surface of a normal bone. There were but two of these cases found in our series, and in both of them the X-ray examination showed a rounded exostosis, with no pedicle present. One case gave a syphilitic history and on a more careful examination revealed a multiple type of lesion. This is one of the cases which cleared up under anti-syphilitic treatment. The second case was that of a boy, aged eleven years, who gave a history of

trauma, the tumor having been present for one year. No biopsy was performed but resection was carried out in May, 1910, and the patient is well at the present time—January, 1930—twenty years later.

#### CHONDROMAS

Chondromas or cartilaginous tumors usually arise in areas of normal cartilage. We present here only one case, that of a white female, aged twenty-six years, who gave a history of pain and tumor in the sternoclavicular joint, with a duration of symptoms of fourteen years. The tumor was excised in 1926 and pathologic sections showed normal cartilage cells, the final diagnosis being hypertrophied joint cartilage.

#### BONE CYSTS

In discussing bone cysts we must take into consideration the epiphysis, as in long bones. The epiphysis in the clavicle is located at the sternal end and does not ossify until after the age of twenty-five years. According to statistical study, the age incidence is between five and eighteen years, the latter being the upper limit except for an occasional latent tumor which may occur in later life and go undiagnosed. In our series of four cases the age incidence ranged 7, 17, 49, and 72, respectively. The location of the first three was at the sternal end, while the fourth case showed multiple cysts at the acromial end. This, again, brings up for consideration the idea of Geschickter and Copeland, who state that bone cysts are healed giant-cell tumors, progressing farther and farther down the shaft from the epiphysis according to the growth of the bone. In the last case mentioned, tumor and pain had been present for about fifty years, while in the other cases symptoms had been present not longer than six months. The X-ray film in each case, although indefinite and vague, showed a central lesion, with definite

cystic expansion of a bony shell. Two cases were curetted and sections showed a typical fibrous tissue lining, diagnosed as osteitis

eleven years, who had had a tumor located in the region of the junction of the clavicle and the first rib. The duration was nine

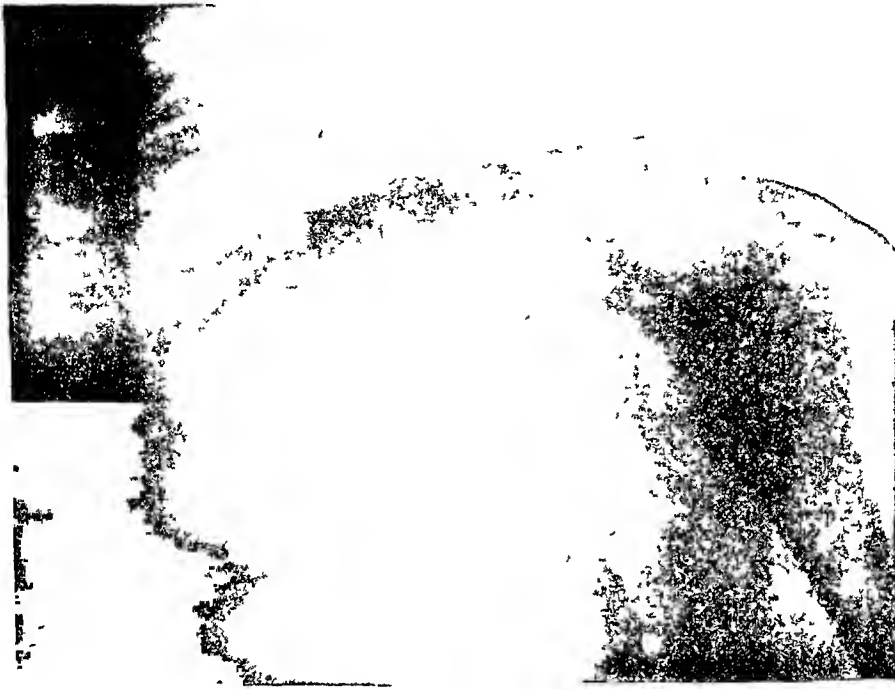


Fig. 1. Widening and sclerosis of the shaft of the clavicle due to syphilitic periostitis.

fibrosa. The ultimate results of the two curetted cases showed the patients to be well five and six years, respectively, while the two cases that were not operated upon were well three and seven years, respectively.

#### GIANT-CELL TUMOR

Giant-cell tumor is a lesion usually described as being located in the epiphyseal region of a long bone, as compared to a bone cyst, which arises in the shaft. Although the clavicle is a superficial bone and exposed to trauma rather frequently, nevertheless it is a rare location for giant-cell tumors. In our one and only case as compared to 226 cases on record, the age incidence does not compare with that usually ascribed as over eighteen years of age. The case under discussion was that of a white male, aged

months. The clavicle and first rib were resected and microscopic examination revealed a typical picture of a giant-cell tumor, namely, a dense stroma made up of a fibrous tissue and cells containing round nuclei. Scattered throughout the matrix were numerous giant cells of the epulis type, whose nuclei corresponded in size and shape to those contained in the surrounding matrix. No signs of malignancy were found. The patient was reported as well in 1928—fourteen years later.

#### SARCOMA

Malignant tumors of the clavicle are also rare. The sarcomatous lesions represented in our series are the chondroblastic and the sclerosing type of osteogenic sarcoma and Ewing's round-cell sarcoma.

One case diagnosed as a chondroblastoma occurred in a white male, aged thirty-two years, who had had pain and tumor in the

In the discussion of sarcoma we must take into consideration Ewing's round-cell sarcoma. There were 70 cases of this type



Fig. 2. Expansion of the sternal end of the clavicle, with rarefaction, due to a benign bone cyst.

region of the second rib and clavicle for six months. The X-ray film showed a lesion of a destructive nature which was deemed inoperable. Coley's serum treatment was instigated but the patient died four months later. No tissue was obtained and the diagnosis was made from the X-ray film and history alone.

The second case of sarcoma was that of a white male, aged fifteen, who gave a history of trauma, pain, and tumor in the mid-clavicle for three months. The X-ray examination showed a sclerosing periosteal lesion, with slight bone destruction. The tumor was excised, followed by post-operative X-ray treatment. Microscopic examination revealed definite new bone formation, with osteoblasts and fibro-spindle cells. The ultimate result showed the patient well ten years later.

of lesion of the whole skeleton, two of which were located in the clavicle. The general location of these tumors may be seen in Table II.

TABLE II

| Location         | Total number |
|------------------|--------------|
| Tibia .....      | 15           |
| Femur .....      | 13           |
| Humerus .....    | 7            |
| Fibula .....     | 8            |
| Radius .....     | 1            |
| Ribs .....       | 1            |
| Pelvis .....     | 5            |
| Scapula .....    | 4            |
| Clavicle .....   | 2            |
| Metatarsal ..... | 2            |
| Tarsal .....     | 1            |
| Skull .....      | 1            |

Our two cases under discussion had tumor and pain. X-ray examination revealed a diffuse involvement, with bone destruction. The treatment of the cases was as follows:  
*Case 1.*—Excision of scapula and outer end

of clavicle in 1920; excision of remainder of clavicle and radium treatment in 1921. Case 2.—Resection performed in 1919; ex-

#### MULTIPLE MYELOMA

Tumors of the multiple myeloma group, as understood from the name, have multiple

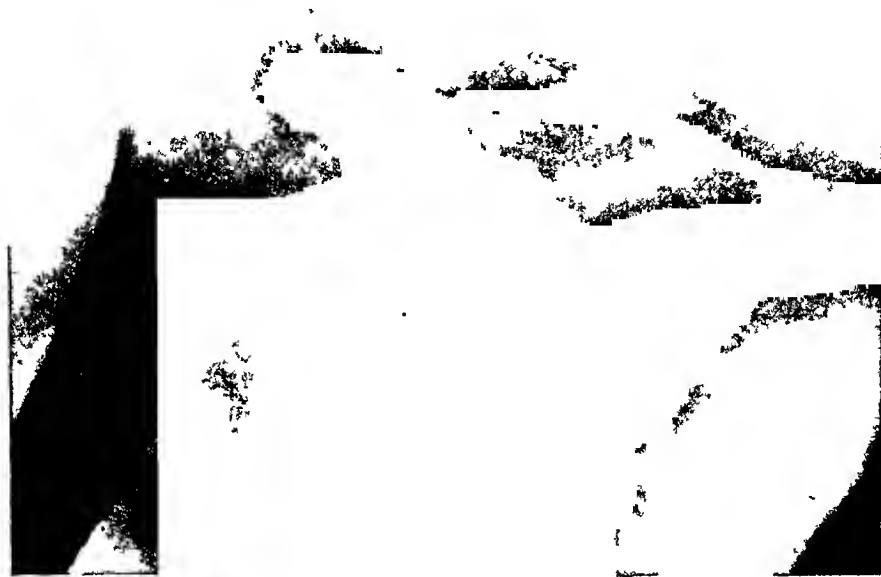


Fig 3 Expansion of areas of destruction and bone formation in a healed bone cyst in the outer end of the clavicle.

cision of recurrence in 1920, followed by X-ray treatments. Both cases showed a microscopic picture of small round cells, with clear-cut nuclei and fibrous stroma, as described by Geschickter and Copeland. Our follow-up system showed that the first case mentioned was well nine years later, while the second case was reported well seven years and three months later.

In the examination of the other Ewing's tumors we find that metastasis is of rather common occurrence: of a series of 25 cases out of a possible 70 showing metastases to other bones, only one case with a primary lesion in the lower tibia showed dissemination to the clavicle and scapula.

The origin of Ewing's tumors is ascribed by some authors to the medullary cavity and by others to a subperiosteal growth. It should be remembered that the clavicle has no medullary cavity.

foci. They give the usual symptoms of pain, swelling, and gradually developing deformity, with fracture. The X-ray appearance is that of a moth-eaten bony structure, so that one can easily see why fractures are so prevalent. The microscopic picture when biopsy is performed is that of a round-cell tumor. The cells are of a plasma type with a nucleus, the chromatin of which has a somewhat spoke-like manner of grouping. Bence-Jones bodies are diagnostic but not an absolute proof.

#### METASTATIC TUMORS

The largest series of clavicular lesions are found in this group. Of 310 cases of metastases to bone, 16 cases had lesions located in the clavicle, being of either a single or multiple focus. Six cases showed lesions



only in the clavicle, while ten had lesions in other bones as well.

In Table III are found the type of lesions metastasizing to bone and the number occurring in the clavicle.

TABLE III

| Primary tumor                  | Total number | Number in clavicle |
|--------------------------------|--------------|--------------------|
| Hypernephroma.....             | 22           | 0                  |
| Prostate.....                  | 110          | 0                  |
| Testicle.....                  | 2            | 0                  |
| Bladder.....                   | 1            | 0                  |
| Uterus.....                    | 6            | 0                  |
| Sarcoma (ovary).....           | 1            | 0                  |
| Carcinoma (stomach).....       | 7            | 0                  |
| Carcinoma (lung).....          | 4            | 0                  |
| Malignant pigmented mole.....  | 3            | 1                  |
| Adenoid cystic carcinoma.....  | 1            | 1                  |
| Carcinoma of heel and ear..... | 1            | 0                  |
| Sarcoma of soft parts.....     | 2            | 2                  |
| Breast carcinoma.....          | 100          | 4                  |
| Undetermined origin.....       | 36           | 8                  |

We can see from this tabulation that metastatic tumors in a sense are rather rare, but as 16 cases were found in a group of this sort and a primary lesion discovered, a mutilating operation could easily be avoided by withholding surgery for X-ray and radium. One of our cases had resection performed, while another had the Coley serum treatment. Palliative treatment is practically the only measure advocated, duration of life after the first signs being from eight to thirty months.

Two of the cases in this series occurred with sarcoma of the soft tissues of the neck. These probably invaded the neck by direct extension, as it is of rather rare occurrence for sarcomatous lesions to metastasize to bones.

One case of special interest is that of a man aged 67, who had a polypoid mass removed from the region of the nose. Section showed what was diagnosed as an adenoid cystic carcinoma of the basal-cell type. The

patient was discharged, only to return about six months later with a pain in the region of the right clavicle, with a recent pathologic fracture. The X-ray study showed a diffuse skeletal lesion involving the skull, cervical vertebræ, clavicles, scapulas, and ribs. A diagnosis of multiple myeloma was made and biopsy was performed. Microscopic examination revealed a picture similar to that of the primary lesion removed from the nose. The patient survived about thirty-six months after the first operation.

#### DIFFERENTIAL DIAGNOSIS

How to diagnose and differentiate these tumors is a most unsatisfactory and difficult subject to discuss. A patient presenting himself with pain in the clavicular region should be questioned carefully as to trauma and venereal diseases. The physical examination should be thorough as regards the bone involvement and other skeletal lesions. X-ray studies of both clavicles should be carried out, and, if any suspicious areas are found, X-ray films of the chest, skull, pelvis, and long bones should be made and examined for multiple lesions. The X-ray study and the history, although probably difficult to interpret, are of great importance. Biopsy should not be carried out unless there is provision for definite and final diagnosis from the microscopic sections. If in doubt, provocative treatment with arsphenamine may be tried with hopeful results in many so-called single lesions. For multiple lesions the primary source should be searched for and thorough X-ray or radium treatment started.

As for the majority of the single lesions, the age incidence of bone cysts and giant-cell tumors, which is under that of most malignant lesions in this locality, should be taken into account.

# NON-SUPPURATIVE OSTEOMYELITIS

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**L**ESIONS of bone without suppuration most frequently cause the greatest difficulty in diagnosis. Both in sarcoma of bone and in the benign lesions of bone which in the roentgenogram resemble sarcoma, changes in the normal bone have taken place which produce changes in the X-ray characteristic of sclerosis, ossification, destruction, and osteoporosis.

Baker<sup>1</sup> in 1877 published a personal observation of a case of necrosis of the femur, without suppuration, in which the differential diagnosis from sarcoma was not established until the gross and microscopic studies were made following amputation. In this case there was a pathologic fracture. This was before the use of the X-ray.

Klemm,<sup>2</sup> from the clinic of Professor Garré, writing on the gross pathology of sclerosing non-suppurative osteomyelitis, calls attention to the fact that sclerosis takes place at the border of the lytic zone where the infectious irritation no longer is sufficient to destroy the bone, and that a circumscribed marrow suppuration may remain latent, the disease picture being governed by the reactive tendency of the bone, the virulence of the organism remaining constant whether extensive suppuration is present or absent.

To-day even with the aid of the roentgenogram the differential diagnosis of non-suppurative osteomyelitis from sarcoma is becoming more and more difficult, because chronic osteomyelitis is coming under observation before the stage of suppuration so much more frequently and in a stage in which the changes produced in the roentgenogram are similar to the changes produced by sarcoma. From 1889 to 1900 we had no cases of non-suppurative osteomye-

litis recorded in this clinic; from 1900 to 1910 only three cases; in the decade from 1910 to 1920, twenty-one cases, and from 1920 to 1930, eighty-one cases. Sarcoma of bone is now coming under observation so early that the most experienced roentgenologists and clinicians, and even the surgeons



Fig. 1. Subperiosteal ossifying type of non-suppurative osteomyelitis in shaft of femur.

<sup>1</sup>W. Morant Baker, *Med Chir Trans*, LX

<sup>2</sup>Paul Klemm, *Beitr. z klin Chir*, 1912, pp 54-72.



Fig 2 Marked ossification of head, neck, and shaft of humerus, pseudo-bone destruction History of trauma

and pathologists most highly trained in the diagnosis of bone lesions, are unable to make this differential diagnosis in many instances until the microscopic section is studied

Prior to 1876, when Sir James Paget<sup>3</sup> read before the Medical-Chirurgical Faculty of London his epoch-making paper on osteitis deformans, this disease also was included in the heterogeneous group of non-suppurating benign lesions of bone The publication of Klemm's article, referred to above, again tended to clarify the atmosphere by calling attention to what is now known as the sclerosing non-suppurative osteomyelitis of Garré.

In this present study of 105 cases of non-suppurative benign lesions of bone grouped

<sup>3</sup>Sir James Paget, Trans Royal Med Chir Soc, 1877, LX, 37-63



Fig. 3 Marked ossification Sections showed chondrosarcoma Amputation. The patient has been well for nine months

in the laboratory under Paget's disease, ossifying periostitis, and non-suppurating osteomyelitis, we are attempting a classification on the basis of the changes produced in the roentgenogram and on etiology. We are including Paget's disease along with the other types of non-suppurative osteomyelitis, because at certain periods in the life history of this disease we are confronted with roentgenograms which simulate certain other types of non-suppurative osteomyelitis



Fig 4 Marked ossification of shaft and epiphysis of femur, never, in our experience, associated with sarcoma.

and it is quite possible that the same etiologic factors prevail. At the same time, we

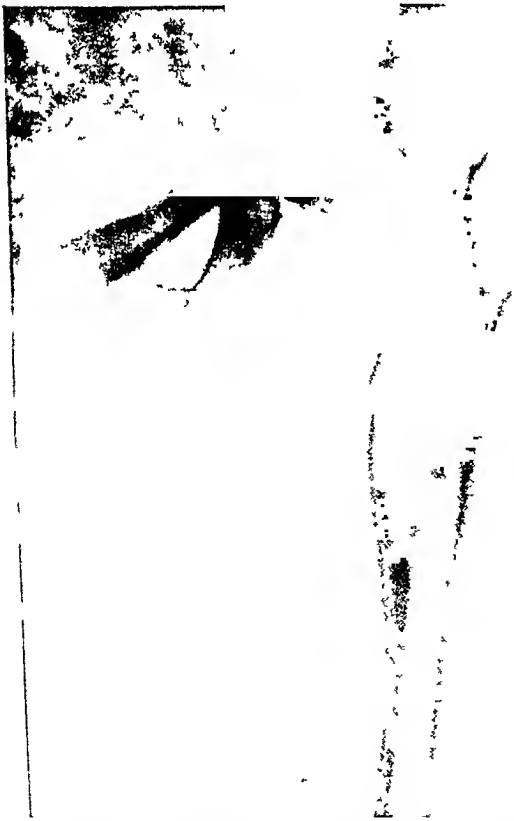


Fig 5 Sclerosing type of non-suppurating osteomyelitis, to be differentiated from sclerosing sarcoma.



Fig. 6 Ossifying and sclerosing type of non-suppurating osteomyelitis, to be differentiated from sarcoma. Biopsy only. The patient has been well for five years. (For photomicrograph see Fig. 13.)

are aware that Paget's disease over a period of years produces certain characteristic changes in the skeleton which do not occur in the other types. It is very helpful in studying an unknown bone lesion to first decide whether the changes appearing in the roentgenograms are due to ossification, destruction, sclerosis, or osteoporosis. From the changes produced in the roentgenogram we have classified non-suppurative osteomyelitis into four groups: sclerosing, ossifying, destructive, and osteoporotic. For the purposes of comparison when attempting to make the differential diagnosis one must bear in mind sarcoma, which may be classified into the same four groups. From the etiologic standpoint we have classified non-suppurative osteomyelitis into four groups: traumatic, syphilitic, post-typhoid, or post-influenzal, etc., and infectious from foci of infection. The classification of non-sup-



Fig 7 Diagnosed sarcoma from X-ray examination and microscopic section. The patient, who refused amputation, had been well for eight years when last heard from in 1922 (For photomicrograph see Fig 14)

purative osteomyelitis then would read as follows:

#### NON-SUPPURATIVE OSTEOMYELITIS

- |                |   |  |
|----------------|---|--|
| 1 Sclerosing   | { | (a) Traumatic                            |
| 2 Ossifying    |   | (b) Syphilitic                           |
| 3 Destructive  |   | (c) Post-typhoid or post-influenza, etc. |
| 4 Osteoporotic |   | (d) Infectious from distant focus        |

#### CLINICAL HISTORY

Non-suppurative osteomyelitis, like sar-

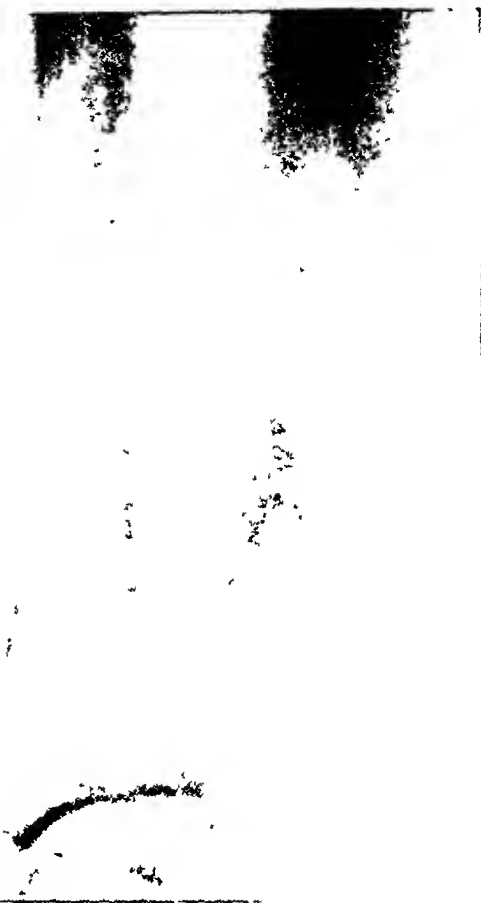


Fig 8 Destructive type of non-suppurative osteomyelitis Wassermann plus. To be differentiated from destructive sarcoma. (For photomicrograph see Fig 16)

coma of bone, is frequently a disease of youth and middle age. By far the greater number of cases in this group came under observation while under forty years of age (75 per cent), and 33 per cent were under twenty. This about coincides with the age incidence in sarcoma of bone. Again, about 25 per cent of the patients came under observation when the disease had been present about three years. The majority of patients with sarcoma of bone, without treatment, have died within this length of time. Seventy-five per cent came under observation at a period when the disease had a duration of from a few weeks to three years, and about half (50 per cent) came under observation when the disease had been present less than one year. It seems that in the future this group will materially

increase, and it is this group which offers the greatest difficulty in diagnosis.

When we study the symptoms of onset we find fracture six times and we know that fracture is rarely followed by malignant

#### ETIOLOGY

Under the heading of etiology we are going to consider trauma, syphilis, focal infections, and those cases which followed shortly after a general infection such as



Fig. 9. Destructive type of non-suppurating osteomyelitis of the clavicle. Wassermann plus. The patient has been well for eight years following anti-syphilitic treatment only.

changes in bone unless the disease has been present before the fracture. Bloodgood has emphasized for years the importance of an X-ray examination after an injury, even though fracture is unsuspected, in order to determine graphically the condition of the bone at the time of the injury. We will speak of trauma later when discussing etiology. With the exception of these six cases in which fracture was a symptom of onset, either pain, swelling, deformity, or limitation of motion was the symptom of onset in practically every case.

typhoid fever, influenza, or acute rheumatic fever. There is a note on trauma in forty-seven instances, but in the history of the majority of cases the fundamental point of the time factor between trauma and symptom of onset is not noted. Trauma was present, therefore, in almost 50 per cent of the cases. In studying the actual X-rays of the entire group trauma is present quite as frequently in the ossifying as in the sclerosing type. It is notable by its absence in the destructive type except in one instance, when it was associated with a posi-

tive Wassermann. In the osteoporotic type the frequency of trauma is perhaps a little less than in the ossifying or sclerosing type.

The Wassermann was plus in eleven instances (10 per cent), and about equally

to the frequent association of syphilis with the ossifying type—syphilitic ossifying periostitis.

The frequency of demonstrable focal infection was about the same as syphilis (10



Fig 10 Localized osteoporosis in epiphysis and shaft of humerus in a patient with multiple lesions of bone. Wassermann positive.

distributed among the four types. There is sometimes an impression that a plus Wassermann is more likely to be associated with the destructive type of non-suppurative osteomyelitis, and I wish to call attention here

per cent). The earlier cases were incompletely studied from this angle, and recently this group has been coming more to the front. There were six cases (only about 5 per cent), which followed typhoid fever,

influenza, or rheumatic fever, and in one case there was a lesion of the femur which on the X-ray film looked like sarcoma.

#### MULTIPLE LESIONS

More than one bone was involved in about 25 per cent of the cases, and the lesion was single in about 75 per cent. When dealing with a multiple disease of bone one thinks of Paget's disease, syphilitic, non-suppurative osteomyelitis, metastatic carcinoma or hypernephroma, and multiple myeloma, rather than of a multiple primary sarcoma, but in three instances there are recorded in the laboratory sarcoma of bone arising in Paget's disease in which there was multiple involvement of the skeleton. Paget's original case with multiple involvement of the skeleton developed sarcoma of the radius. Therefore multiplicity of the lesion does not entirely rule out sarcoma.

#### BONE INVOLVED

The tibia and the femur are each involved in about 20 per cent of the cases; the humerus in about 8 per cent; the pelvis in about 5 per cent; the skull in about 5 per cent, and the clavicle in about 5 per cent. The remaining 35 per cent includes lesions of the radius, ulna, fibula, metatarsal and metacarpal, carpal and tarsal bones, phalanges, ribs, vertebræ, and jaw. The jaw, tarsal and carpal bones are least frequently involved.

#### X-RAY RESEMBLANCE TO SARCOMA

One asks the question, "How often does the X-ray appearance of non-suppurative osteomyelitis resemble the X-ray appearance of sarcoma?" In 66 per cent of the cases we felt from the X-ray examination alone that we were dealing with a benign lesion, and that there was a question as to sarcoma in about 33 per cent.



Fig. 11. Localized osteoporosis in epiphysis and shaft of femur. Sections showed myxoma. Amputation. Death in 1930 from metastasis six years after amputation.

#### X-RAY APPEARANCE OF THE OSSIFYING TYPE

On the X-ray film the area of ossification or of new bone formation may vary from the congenital spur, in the shape of a horn attached to a normal shaft (type of congenital exostosis), to the mushroom-like pedunculated exostosis sometimes associated with fracture, occasionally seen in riders' bone, attached to the pelvis. The area of ossification may vary from the large irregular mass of new bone attached to a normal shaft throughout its entire base, presenting the picture of ossifying myositis becoming secondarily attached to the shaft, to an area of ossification beneath the periosteum, producing subperiosteal localized ossification (Fig. 1). When there is a large area of bone formation completely surrounding the shaft of the bone, casting irregular shadows over the shaft and producing the picture of pseudo-bone destruction, there is always difficulty in diagnosis. We have an instance of this type (see Fig. 2) in a case of the ossifying type of non-suppurative osteomyelitis. The patient was a man aged



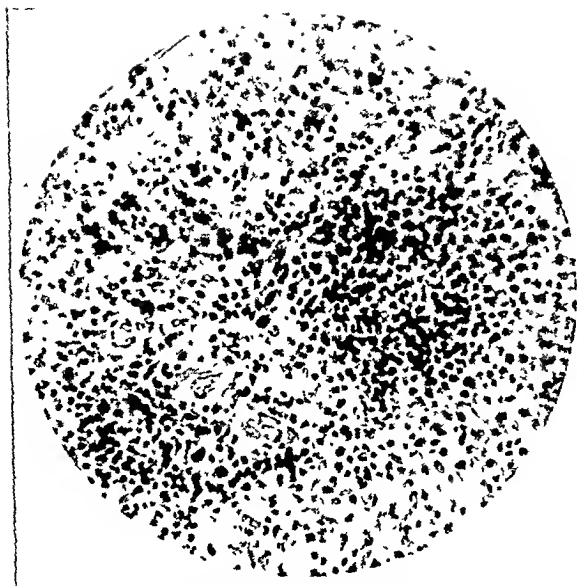


Fig. 16. Lymphoid-cell granulation tissue from bone shown in Figure 8.

films of the chest and pelvis for the demonstration of any possible metastasis or evidence of Paget's disease. In those instances in which metastasis is demonstrated in the X-ray examination or Paget's disease is suspected, there should be an X-ray examination of the skull in the lateral view. Routine dental films of all the teeth are indicated in order to eliminate this frequent cause of focal infection.

#### TREATMENT OF BONE LESIONS

First, we must consider the group which in the X-ray examination resembles sarcoma. We mentioned above that about 33 per cent fall into this group. It seems wiser here to try the effect of radiation first to demonstrate the presence or absence of a radiosensitive tumor, and at the same time to give an opportunity for about two weeks' observation. In a number of instances, during the course of radiation therapy, there has been pus formation or discharge of sequestrum, thereby establishing the diagnosis of a benign lesion.

In nine, or about 33 per cent, of the cases in which the X-ray findings were suspicious of sarcoma, biopsy, partial excision, or re-

section was done to establish the diagnosis, in a number of instances among the earlier cases without preliminary radiation. It seems that we are justified in making the statement, "when the X-rays suggest sarcoma, and when the tumor is radioresistant, and when the foci of infection are eliminated, we are justified in exploratory operation, provided the tumor—if malignant—is operable." In some instances, even though the Wassermann may be negative, it seems wise to give a provocative injection of arsphenamine with another Wassermann reaction.

There has been only one amputation in this series and that was in the case of a patient with Paget's disease, the lesion of the tibia showing a great deal of bone destruction. In one case in which the X-ray findings suggested sclerosing sarcoma (Fig. 7), mentioned above—a lesion of the upper third of the shaft of the femur—there was a biopsy in another clinic. The sections were diagnosed sarcoma. The patient refused amputation and was well eight years later when last heard from in 1922. In another instance a young man aged eighteen had pain for two weeks following a trauma two weeks previously. There was a lesion in the upper third of the femur, in the X-ray examination looking like sarcoma. As we have never cured a case of sarcoma of the upper third of the femur by amputation, and, because of the location of this lesion, the patient was given X-ray treatment. The sequestrum came away. He has now been well for six years. Five years ago we saw a young man, nineteen years of age, with a single lesion of the lower third of the femur (Fig. 6). There was no history of trauma and the Wassermann was negative. The X-ray examination showed sclerosis combined with ossification. At exploration the diagnosis of non-suppurative osteomyelitis was made from the frozen section, and, other than biopsy, nothing further was done. The patient has now been well for five

years. The results are now up to date. We have heard from the majority of these patients, and there has been no death from sarcoma.

#### MICROSCOPIC PATHOLOGY

Histologically, the picture varies from the remains of necrotic bone, with granulation tissue in which plasma cells predominate (Fig. 12), or compact bone with enlarged haversian canals, like that seen in Paget's,

and fibrous stroma such as is seen in osteitis fibrosa, with many small capillaries sometimes showing perivascular inflammation easily differentiated from sarcoma (Fig. 13), to bone in which the haversian canals may be almost completely absent, with granulation tissue in between the bony lamellæ of the round- and spindle-cell type suggesting sarcoma (Fig. 7). In the syphilitic lesion the granulation tissue is of the lymphoid-cell type, and may suggest Ewing's tumor (Fig. 16).

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# BONE METASTASES

## A STUDY OF 334 CASES

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ILLUSTRATIONS BY HERMAN SCHAPIRO

IN the following study an attempt will be made to correlate the various clinical features of the different metastatic lesions localized in the bones, together with the pathologic process involved; and to clarify the rather obscure results which have hitherto obtained with regard to the treatment of bone metastases (see Chart I and Table I).

For purposes of analysis it has been found convenient to group the 334 cases of osseous metastases according to the primary tumor from which the dissemination occurred. The result of this analysis has brought forth many interesting and novel features in the natural history and clinical course of the various secondary bone deposits.

*Breast*—One hundred carcinomas of the breast were studied with secondary bone involvement. The majority of the primary

lesions microscopically were found to be of the scirrhous type (58 cases); with a few instances of adenocarcinoma (six cases); medullary carcinoma (four cases); comedo-carcinoma (three cases), and colloid carcinoma (two cases). In one patient the primary lesion was found to be fibrosarcoma.

The bones most frequently involved were found to be, in the order of their incidence: the spine, pelvis, femur, skull, ribs, and humerus, while metastases in the forearm and the lower leg were of infrequent occurrence. There was no definite relation found between the primary lesion and the homologous bony structure. In 16 cases in which there were complete data, eight cases showed a primary lesion with contra-lateral bone metastases, while an equal number of patients revealed ipso-lateral osseous lesions.

TABLE I.—METASTATIC BONE LESIONS

*Incidence of Cases—Pathologic Fracture: Five-year Cures*

| Primary malignancy         | Number cases | Osseous metastases |          | Pathologic fracture |          | Patients living over five years |          |
|----------------------------|--------------|--------------------|----------|---------------------|----------|---------------------------------|----------|
|                            |              | No cases           | Per cent | Number cases        | Per cent | Number cases                    | Per cent |
| Breast carcinoma           | 1914         | 100                | 5.2      | 15                  | 15       | 1                               | 1        |
| Prostatic carcinoma        | 1040         | 134                | 12.8     | 3                   | 0.2      | 0                               | 0        |
| Stomach carcinoma          | 537          | 7                  | 1.3      | 1                   | 14.3     | 0                               | 0        |
| Colon and rectal carcinoma | 497          | 3                  | 0.06     | 1                   | 33.3     | 0                               | 0        |
| Melanoma                   | 169          | 3                  | 1.77     | 1                   | 33.3     | 1                               | 33.3     |
| Uterine carcinoma          | 86           | 5                  | 5.6      | 0                   | 0        | 0                               | 0        |
| Hypernephroma              | 63           | 22                 | 34.9     | 10                  | 45.4     | 1                               | 4.5      |
| Ovarian carcinoma          | 60           | 1                  | 1.6      | 0                   | 0        | 0                               | 0        |
| Testicular sarcoma         | 42           | 1                  | 2.4      | 0                   | 0        | 0                               | 0        |
| Lung carcinoma             | 24           | 4                  | 16.6     | 1                   | 25       | 0                               | 0        |
| Ovarian sarcoma            | 15           | 1                  | 6.6      | 0                   | 0        | 0                               | 0        |
| Thyroid malignancy         | 15           | 6                  | 4        | 2                   | 33.3     | 0                               | 0        |
| Testicular carcinoma       | 13           | 1                  | 7.7      | 0                   | 0        | 0                               | 0        |
| Undetermined malignancy    | --           | 37                 | --       | 15                  | 40.5     | 2                               | 5.4      |
| Nasopharyngeal carcinoma   | --           | 1                  | --       | 0                   | 0        | 0                               | 0        |
| Squamous-cell carcinoma    | --           | 2                  | --       | 0                   | 0        | 0                               | 0        |
| Soft-part sarcoma          | --           | 2                  | --       | 0                   | 0        | 1                               | 0        |
| Bladder carcinoma          | --           | 1                  | --       | 0                   | 0        | 0                               | 0        |
| Esophageal carcinoma       | --           | 1                  | --       | 0                   | 0        | 0                               | 0        |
| Ileac sarcoma              | --           | 1                  | --       | 0                   | 0        | 0                               | 0        |
| Liver carcinoma            | --           | 1                  | --       | 0                   | 0        | 0                               | 0        |

Many cases having multiple lesions on both sides of the body were valueless in determining this relation of primary tumor to metastases.

Clinically, pain of a severe rheumatic character was an important feature. When the metastatic foci were located about the spine, girdle pains and many other neurological manifestations appeared. Occasionally, pain preceded roentgenologic evidence of bone metastases for from three to eighteen months. The majority of the cases eventually showed a secondary type of anemia, with its complications, as the disease progressed. An occasional case report in the literature (1, 2) was found in which a pseudo-pernicious type of anemia was present, with a color index of over one, a slight leukocytosis, nucleated red blood cells, myelocytes, and myeloblasts. The ordinary anemia of cancer, according to Piney (3), is not dependent upon the presence of carcinomatous deposits in the marrow, but upon intrinsic changes in this tissue. The terminal phase of the disease was a progressive emaciation, usually with much pain, and when the lungs were involved (19 cases) respiratory embarrassment, with spitting of blood and paroxysms of coughing, were added features of discomfort.

Pathologic fracture occurred in 15 instances, 13 being in the femur, one in the ilium, and one case was recorded with multiple fractures of the ribs.

As seen by the X-ray, metastatic bone lesions from breast carcinoma were found to be most often multiple (Figs. 1-A and 1-B, Path. No. 37,870), presenting themselves as a single lesion (Fig. 2, Path. No. 23,091) in only one-fourth of the cases. The majority of the solitary foci were in the vertebræ or femur. Two types of metastatic lesions were noted in the X-ray films: The more common one was an osteolytic or bone-destructive lesion, while the other was a sclerosing or bone-forming process, the latter occurring in outspoken

## METASTATIC CARCINOMA

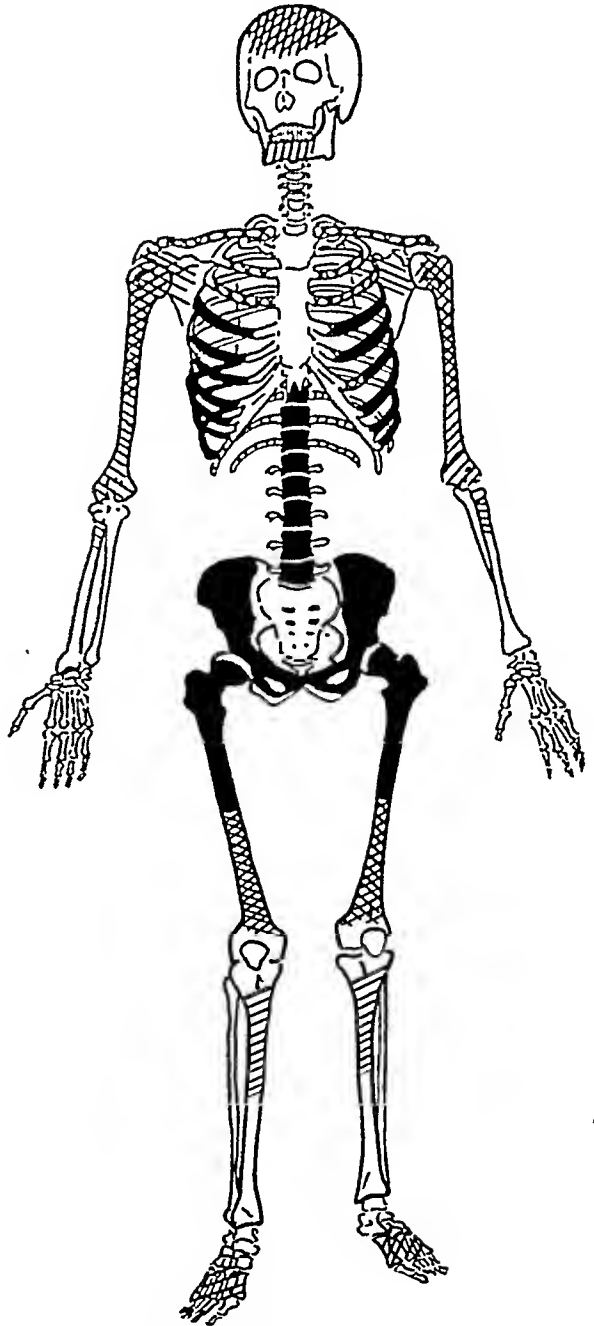


Chart I. Incidence of metastatic lesions of epithelial and connective tissue origin according to skeletal location. The solid black areas indicate the most frequent sites; the checked areas, the common sites; the diagonal lines, the occasional sites, and the white areas, rare sites.

fashion only twice in this series of breast cancers, together with an occasional case reported in the literature. In the long bones,



Figs 1-A and 1-B Illustrating multiple foci in the skeleton, found to be predominant in mammary carcinoma (1-1) Roentgenogram of the shoulder girdle showing multiple involvement of the scapula, humerus, clavicle, and ribs Note the punched-out areas, with little or no bone formation (1-B) Involvement of the upper shaft and head of the femur and adjacent pelvis Path No 37,870

the metastatic deposit was often found well above the average entrance of the nutrient artery in the case of the femur, and above or below it, in the case of the humerus. Mottling, representing an increase in bone density, was often found within the areas of destruction, together with thickening of the cortex above or below the site of metastasis (Fig 3, Path No 35,420), and microscopically this proved to be an attempt at bone repair or fibro-ostosis (6). Bloodgood (7) has pointed out that evidence of such new bone formation may be used as a point in differential diagnosis in multiple tumors of the bone. When this new bone formation occurs as mottling within an area of bone destruction, it favors the presence of a metastatic process as op-

posed to the more definitely punched-out areas of bone destruction seen in multiple myeloma and other similar lesions of the bone. The pelvis, vertebræ, skull, ribs, scapulæ, clavicles, and sternum showed the same typical medullary involvement as the femur and humerus. The lack of distortion, or bending, of the bones was evidenced, due partly to the advanced stage of the disease, to X-ray therapy, which is not infrequently resorted to, and also to the brittleness of the bones, a consequence of age, making fracture, rather than bending, the rule.

An analysis of the gross and microscopic pathologic changes aided materially in the interpretation of the roentgen observations and of the modes of metastasis. The femur



Fig. 2. Metastatic involvement of the greater trochanter and neck of the femur, illustrating metastatic carcinoma as a single lesion in breast cancer. Path. No. 23,091.



Fig. 3. Roentgenogram showing metastases in the upper end of the femur, with mottling representing increased bone density within the areas of destruction. There is also thickening of the cortex below the site of metastasis. Path. No. 35,420.

and the humerus offered the most valuable information in the study of the gross material. It was brought out that metastases occurred both *via* the vascular route and by direct extension from other bones through the lymphatics. The humerus in most instances was found to be involved principally in the medullary and cortical areas in the shaft area, with subsequent invasion of the head. The femur often showed metastases in the head about the fovea capitis (Figs. 4-A and 4-B, Path. No. 40,002) and in the region of the greater trochanter, extending down into the shaft. The microscopic examination of sections taken from various points in these bones revealed destruction of the spongy and the cortical bone by the direct contact of the tumor cells with the bone (Fig. 5, Path. No. 40,002), and, to a lesser degree, by the activity of the osteoclasts destroying

dead bone. Abundant evidence was found microscopically in proof of a natural tendency of bone to react by direct transition of fibroblasts to osteoblasts to osteoid tissue, in an effort to protect itself from further invasion and to rebuild that part already destroyed (Fig. 6, Path. No. 12,761). X-ray therapy in many instances caused a similar reaction when employed to a sufficient degree. The variation in the location of metastatic foci of the affected bones is to be explained in a subsequent paper as being the result of either a lymphatic permeation or a vascular mode of metastasis.

The treatment of the osseous lesions was considered for purposes of analysis on three types of patients: first, those who had a radical amputation of the breast; second, those who had only simple breast amputation or local excision, and third, those on whom no operation was performed, and who re-



Fig. 4-A. The upper end of the femur, the seat of metastasis from breast carcinoma. Note the tumor invasion about the fovea capitis and in the region of the greater trochanter. The neck has collapsed, with approximation of the head and the shaft. Path. No. 40,002.

ceived only various forms of palliative treatment

In Group 1 there were 74 patients showing subsequent metastasis to bone. The average interval between the appearance of the primary tumor and the metastasis to bone was 32.5 months, and the time between radical removal of the breast and metastases averaged thirty months, with a few exceptions who developed bone lesions at intervals as late as from nine to twenty years. The malignancy in the patients of Group 1 was principally of the scirrhus type. The microscopic examination in 52 of the cases showed scirrhus carcinoma; medullary carcinoma (four); comedocarcinoma (three); adenocarcinoma (three); colloid carcinoma (one), with eleven unclassified.

In Group 2, 18 cases were found with an average interval of 29.1 months between the appearance of the primary tumor and the

first evidence of metastases, while the interval between the breast operation and osseous involvement was 16.7 months. The types of microscopic pathology in the various primary breast tumors were, in the order of their frequency, unclassified (seven); scirrhus (six); adenocarcinoma (three); colloid carcinoma (one), and fibrosarcoma (one).

Group 3, or the inoperable group, contained eight cases. The interval between the appearance of the primary tumor and the metastases ranged between one and twenty-four months.

Treatment as given in this clinic is based upon the clinical experience of Dr. J. C. Bloodgood and Dr. Max Kahn. The X-ray treatment consists of 12 thirty-minute exposures, using 200 kilovolts. and five milliamperes, filtered through a filter combined of 0.75 millimeter copper and 1 millimeter aluminum, with a 25 cm. diaphragm opening and a 50 cm. focal distance.

A total of ninety minutes is given over each portal of entry in doses of thirty minutes each on consecutive days, four portals of entry being used. If further treatment is indicated, the above procedure is repeated after a free interval of three months or more, depending upon the condition of the patient.

In Group 1, two cases have survived the metastases for 71 and 48 months, respectively. After receiving irradiation by the X-ray the average duration of life was 18 months, as compared with 11.5 months for those who received no X-ray therapy.

In Group 2, the average duration of life of those patients with metastases who received X-ray therapy was 16.2 months as compared with 12.8 months for those who did not receive roentgen therapy.

In Group 3, the patients irradiated by the X-ray lived 10 months, while those without X-ray therapy lived 7.8 months.

Resection of the affected part apparently

had no effect on the duration of life, but did relieve pain, while roentgen therapy gave relief from the excruciating pain experienced in the diseased bone and in some instances definitely prolonged life. Many such in-

stances (29,461), while others involved the heads of the humerus and femur, together with the pelvis, suggesting strongly both a lymphogenous and hematogenous mode of metastases, especially the last-mentioned, where



Fig. 4-B. A low-power photomicrograph of a section taken from the region of the fovea capitis, depicted in Figure 4-A. The tumor invasion can be seen below the site of the lesion. The joint cartilage is intact on either side of the tendinous attachment. Path. No. 40,002

stances of relief from pain by X-ray therapy have been reported (8, 9, 10).

**Hypernephroma.**—Bone metastases were found in 22 cases of hypernephroma. The bones usually affected, in the order of their frequency, were: humerus, spine, femur, pelvis, ribs, bones of the feet, skull, sternum. The age incidence varied from 21 to 81 years. The clinical course was typical of metastatic bone lesions. A unique feature (11) was sometimes demonstrated on examination by the pulsatile character of the tumefactions. Pathologic fracture occurred in ten patients (45.4 per cent); six times in the femur, three times in the humerus, and in one instance multiple rib fractures were found. The bone lesions appeared in the X-ray films either as single or multiple foci, located in one or more bones. Single deposits were found in a long bone in the majority of instances (59 per cent).

Many of the lesions were found at sites of nutrient vessels (Fig. 7, Path No.

no intervening structures were found to be involved at autopsy. There was very little tendency on the part of the bone to react to the tumor by fibro-ostosis. The gross and microscopic pictures were of primary medullary involvement by the invading tumor, with osseous destruction and practically no healing reaction (Fig. 8, Path. No. 42,906).

In two of the cases with complete records, X-ray therapy was used in one instance, and in the other roentgen therapy with Coley's serum and amputation. Though pain was relieved, the disease proved fatal in both cases within two years.

Metastases of bone as seen in the various forms of primary malignancy in the male and female genital tract were studied in groups according to the primary organ involved.

**Prostate.**—In carcinoma of the prostate, 134 instances of metastases to bone were found among 1,040 cases affected by cancer. It must be pointed out, however, that only





Fig. 5. Microscopic picture of the tumor in the upper end of the femur shown in Figure 4-A. Note the destruction of the bone by direct contact of the tumor cells, the tumor being composed of epithelial cells arranged in nests, in places surrounded by fibrous tissue. Path. No. 40,002.

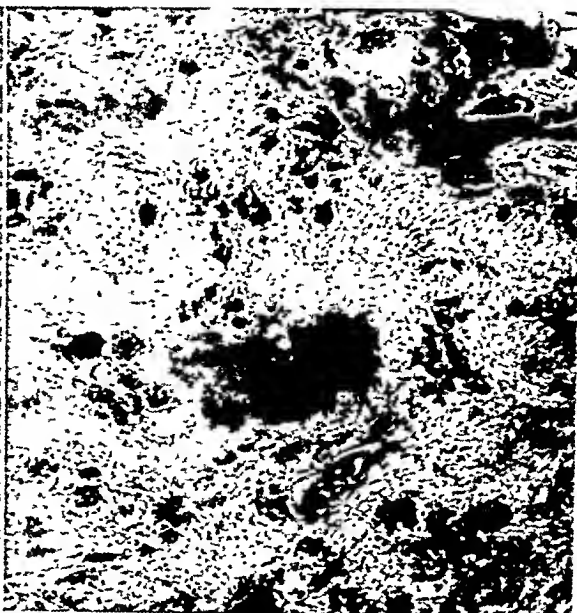


Fig. 6. A photomicrograph illustrating the natural tendency on the part of bone to react by direct transition of fibroblasts to osteoblasts to osteoid tissue, in order to protect itself from tumor invasion and to rebuild that part already destroyed. Note the sclerosis and bone formation crowding the tumor cells into strands and islands. Path. No. 12,761.

about 50 per cent of the total number of cases had been examined by the X-ray and in only 25 per cent of this number were metastases found.

The bones most frequently involved were the pelvis and vertebrae, more rarely the femurs, and in two instances the lower end of the tibia and the skull were invaded. The patients clinically suffered varying degrees of pain in the region of the pelvis—stiffness of the hip joints and sciatic discomfort. Many cases showed symptoms of urinary obstruction, with a subsequent progressive emaciation and secondary anemia. The age incidence was that of middle and late life (46 to 75 years).

As depicted in the X-ray film, all the metastatic lesions in the bones were predominantly of an osteoplastic nature (Fig. 9, Path. No. 42,182), a characteristic of prostatic carcinoma, in which there is marked bone formation with some destruction. Bumpus (12), in a study of 362 cases at the Mayo Clinic, found osteoclastic

changes predominating in a few instances, but the majority of the bone lesions showed an osteoplastic reaction.

Upon gross examination of the material at hand, the metastatic nodules appeared as white or grayish nodules, surrounded and often permeated by a healing bone reaction. This response to tumor invasion was found to be quite the reverse of that usually seen in other metastatic lesions, except where osteoclastic lesions had been treated by X-ray therapy. This bone reaction to prostatic carcinoma suggested strongly the hypothesis that the invasive powers of the secondary tumor deposits were of such moderate character that bone proliferation kept pace with the tumor invasion. Roentgen therapy offered relief from pain but was not effective in eradicating the lesion or in greatly prolonging life. Amputation of a leg was done in two instances for relief of pain.

*Testicle.*—Malignancy of the testicle, with metastases to bone, was of rare occurrence—



Fig. 7. Roentgenogram of the shaft of the humerus, the seat of metastatic hypernephroma. The destroyed bone is to be seen at the site of the nutrient vessels and at the attachment of the deltoid muscle. Path. No. 29,461.

only two patients in this group. One was a case with carcinoma of the testicle; the other, a sarcoma of the testicle. A review of the clinical course revealed progressive emaciation, with various neurological phenomena. In one case a lump appeared in the abdomen, attached to the retroperitoneal region, following removal of the testis. The ages of the men were, respectively, 40 and 56 years.

The X-ray film showed a destructive type of lesion, with no osteoplastic reaction. Roentgen therapy proved beneficial in the carcinomatous bone metastases by relieving pain, but little good was derived from irradiating the testicular sarcoma.

*Bladder.*—One example of carcinoma of the bladder, with metastases to bone, was

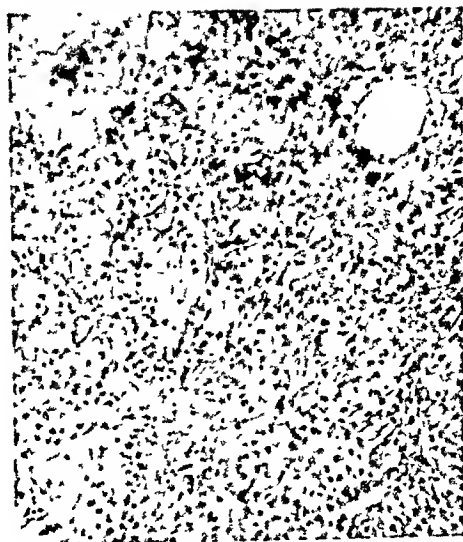


Fig. 8. Photomicrograph of tissue removed from a bone, the seat of metastatic hypernephroma. Note the clear foam-like cytoplasm in many of the cells. Path. No. 42,906.

recorded, with secondary deposits in the bones of the foot. Subsequently the lesion in the bladder (14) was found, following a severe attack of hematuria. No ultimate result could be arrived at in this case.



Fig. 9. Roentgenogram depicting multiple involvement of the pelvis and femora by metastatic carcinoma arising in the prostate. Such metastases are predominantly osteoplastic in nature. Path. No. 42,182.

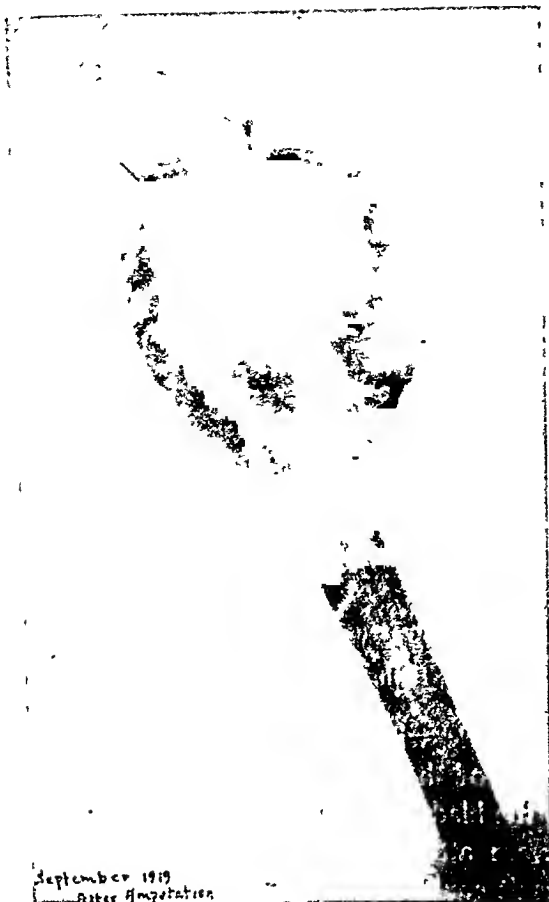


Fig. 10. A roentgenogram of the upper end of the humerus showing involvement of the upper end of the shaft near the epiphysis, apparently beginning as a central lesion, expanding and destroying the cortex. Path. No. 26,823.

*Uterus*.—Carcinoma of the uterus metastasized to bone in five instances. Two of the primary tumors were in the cervix, while three were found in the body of the uterus. The age incidence in this group extended from 35 to 60 years.

Clinically, varying degrees of pain, with disturbance of function in the affected extremities, were common symptoms. The course of the advancing disease was dominated by secondary invasion of the primary tumor to surrounding organs. Apparently due to the fact that uterine carcinoma as a whole invades lymph nodes relatively late, there is a striking tendency on the part of the neoplasm to remain localized to the



Fig. 11. Roentgenogram showing diffuse cystic destruction in the lower shaft of a femur from carcinoma of the stomach, metastasizing to the bone. Path. No. 39,012.

uterus or to its immediate vicinity until late in the disease, in contradistinction to cervical carcinoma, which invades the parametrium early. The roentgenogram of the osseous metastases revealed areas of bone destruction, four times in the pelvis, twice in the femur, once each in the humerus, skull, and metacarpal bones. There was no evidence of new bone formation and no periosteal reaction. The roentgen ray and radium proved particularly unsatisfactory in this group of cases.

*Ovary*.—Two instances of ovarian malignancy, with metastases to bone, were found among 69 such cases in this laboratory. In one instance the patient (age 47) was found

to have carcinoma, and in the other, sarcoma of the ovary (age 14). The bones affected in the first case were the third metatarsal, and in the second the skull, femur, and pelvis.

Clinically, pain in the affected bone was

abdomen, tumor, and ascites, were the first symptoms in the second case. X-ray therapy gave some relief from pain, but death intervened twenty months after the onset of symptoms.

*Thyroid.*—In reports which deal with a

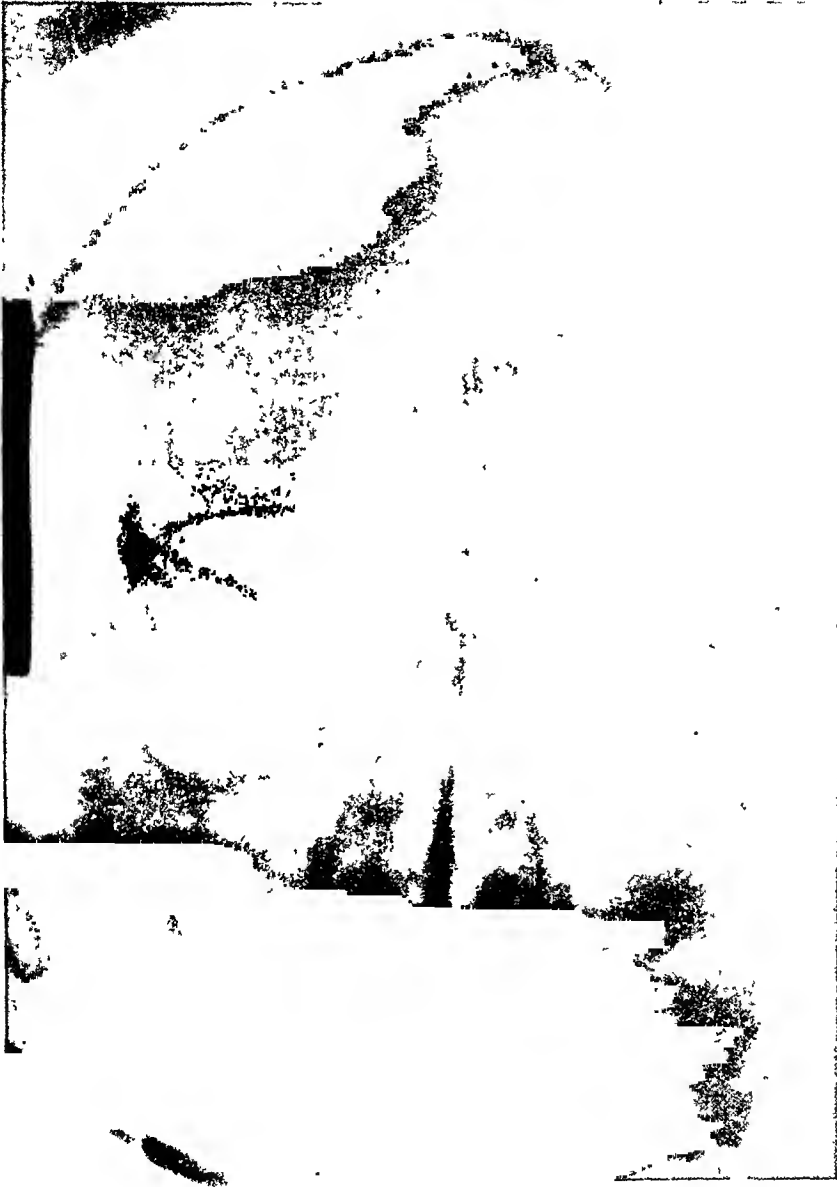


Fig. 12-A Roentgenogram of the skull showing diffuse mottling in the frontal area, representing bone destruction by metastatic carcinoma arising in the lung. Path. No. 14,500.

the first symptom of the disease in one case, while manifestations in the region of the primary tumor, namely, pain over the lower

large series of cases of thyroid malignancy, metastasis to bone is of relatively frequent occurrence, and Ewing (13) f t l a



Fig. 12-B. Photomicrograph of tissue represented in 12-A, showing bone destruction by direct contact of tumor cells. Path. No. 14,500.

ion that the bones in thyroid malignancy are involved only less frequently than with mammary and prostatic cancer.

In our series of metastatic lesions only six cases of thyroid malignancy were found with metastasis to bone, with the peak of age incidence well above forty years. There were too few cases to allow one to draw any conclusions upon the incidence of bone involvement, but Ewing (13) gives the following order of frequency in the bones affected: skull, sternum, spine, ribs, humerus, femur, and pelvis. The metastases appeared near the epiphyses, either as central or subperiosteal lesions (Fig. 10, Path. No. 26,823). The clinical course was usually one of progressive emaciation, with symptoms referable to those bones which were the seat of metastases. Pressure symptoms in the neck region caused pulmonary embarrassment. In spite of X-ray therapy in one instance and Coley's serum, radium therapy, subsequent amputation, and X-ray therapy in another case, a fatal termination supervened, with only relief from pain in every case.

*Gastro-intestinal tract.*—Among lesions

of the gastro-intestinal tract the stomach was found to be the most frequent site of a primary tumor which subsequently metastasized to bone. From a series of 537 patients who were found to have carcinoma of the stomach, only seven revealed bone metastases. The age of the patients affected ranged between 39 and 71 years. The bones involved were, in the order of their frequency: ribs (4 cases); pelvis and femur (3 cases); vertebrae (2 cases); sternum, skull, and scapula (one each). Most of the cases were examined only at autopsy, but in two cases in which X-ray examinations were made, either diffuse mottling and no distortion of the bone shell was present, or an expansion accompanied the central cystic lesion (Fig. 11, Path. No. 39,012).

The clinical course was usually one of emaciation, pain in the affected parts, and often neurological manifestations. An interesting feature of the blood was noted in one case, with enlargement of the lymph nodes. The white blood cell count was 10,600, with polymorphonuclear cells 30 per cent, eosinophiles 6 per cent, basophiles 2 per cent, myelocytes 26 per cent, myeloblasts 1 per cent, large lymphocytes 16 per cent, and small lymphocytes 11 per cent. The patient also showed tertian malarial parasites at examination.

Piney (3) and others have reported a pseudo-pernicious type of anemia in cases of carcinoma of the stomach, and, as was pointed out previously in this paper, breast carcinoma may show a similar blood picture.

Single examples of bone invasion from malignancies of the esophagus, cecum, sigmoid, rectum, ileum, and liver are recorded, with many of the features exemplified by metastatic lesions from stomach carcinoma. Only one patient in the series was treated by X-ray therapy, with some relief from pain but apparently without prolonging his life.

*Lung.*—Bone involvement was found to be present in four cases of carcinoma of the

lung. A wide variety of bones were involved, including the lumbar spine, pelvis, ribs, and skull. The clinical course of the disease revealed nothing unusual save that reported in other metastatic lesions. The X-ray film showed bone destruction with slight new bone formation, often within the area of destruction (Figs. 12-A and 12-B, Path. No. 14,500). Hirsch and Ryerson (14) report four cases in which the early diagnosis simulated "endothelioma of bone," and urge complete autopsies to rule out metastases from primary lung tumors.

*Melanoma.*—Melanocarcinoma is not of rare occurrence but few examples are cited as metastasizing to bone, only three such instances being recorded in this laboratory. The location in the long bones appeared about the site of nutrient vessels (Fig. 13, Path. No. 10,764). The clinical features of this type of bone metastasis were pain extending over a period of a year or more, occasionally pathologic fracture, and ultimately the symptoms of generalized dissemination of cancer. However, in this group of cases there is a patient who has been living for seven years and six months, following amputation of the left arm.

Interesting isolated examples of soft-part sarcoma (two cases); epithelioma (two cases), and adenoid cystic basal-cell carcinoma of the nasopharynx (one case) are recorded. They have followed the usual clinical course and termination of metastasis in general.

In many instances the clinician is unable to definitely diagnose the bone lesion after a thorough examination has been made, including X-ray plates, and when a biopsy is done little more can be said definitely concerning the etiology of the tumor.

There were 31 such cases under analysis in this laboratory and in none of them were we able to establish the location of the primary tumor. It is to be pointed out that the lesions were located in various parts of



Fig. 13. Roentgenogram showing melanocarcinoma metastasizing to the upper third of the tibia. Note the expansion and cystic destruction of the shaft. Path. No. 10,764.

the skeleton and many of them were multiple. Not a few of the patients were relieved from pain for long periods of time by the administration of X-ray therapy, and in a few instances they lived from three to eight and one-half years following X-ray therapy or amputation of the affected part.

The question as to the mode of metastases immediately suggests itself when one reviews such a wide variety of lesions, and when the circumstances surrounding the

primary lesion and secondary metastases are analyzed, one cannot but be convinced of the dual method of dissemination—that is, by lymphatic permeation and embolism *via* the blood stream. This will be taken up in detail in a subsequent number of the *Archives of Surgery*.

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# AN X-RAY AND CLINICAL STUDY OF THE BONES OF THE HANDS AND FEET

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ONE out of every ten neoplasms occurring primarily in bone involves the small bones of either the hands or feet. Tumors thus located are met with sufficiently often to make it important for the roentgenologist or practitioner dealing with lesions of bone to familiarize himself with the peculiarities of this group of new-growths. In an attempt, therefore, to study tumors involving the small bones of the hands and feet it is necessary not only to study the X-ray characteristics, but also the clinical history and microscopic findings.

This study is based on 145 lesions of the small bones recorded in the Surgical Pathological Laboratory of Johns Hopkins Hospital from 1890 to 1930. A similar study was made in 1926 and reported in *RADIOLOGY* in April, 1927 (1).

## EXOSTOSES

Of the forty cases in this group, the largest number, twenty-two (or about 50 per cent), involve the os calcis. On the X-ray film they are easily recognized. They are nearly always single but in a few exceptions they may be multiple. Such a lesion manifests itself as a bony spur of variable size, attached by a pedicle which may be broad. Exostoses usually have smooth borders which may be pointed, cauliflower-like, or rounded in appearance. They are sometimes cystic or they may be fractured and may be without symptoms. They are benign and the treatment consists chiefly of excision if they cause pain by pressure. If they produce no symptoms, they are best left alone. When once properly excised they seldom recur. The majority of the cases in this group occurred in males. The

youngest patient was seven years of age and the oldest sixty-five years. The duration of the symptoms varied from two months to about fourteen years. The microscopic findings consisted chiefly of cancellous bone, with an overlying area of adult cartilage.

## CHONDROMYXOMA

The chondromas numbered 45 cases, almost equally divided as to sex, 24 occurring in females and 21 in males. The youngest patient was six years of age and the oldest eighty years; 25 were between the ages of twenty and fifty years. In 30 cases the phalanges of the hand were involved; in 7, the metatarsals; in 6, the phalanges of the feet, and in 2, the tarsals. There were no cases involving either the carpals or the metacarpals. This is valuable from a diagnostic standpoint in differentiating these lesions from benign giant-cell tumor and bone cyst, which, when occupying a position

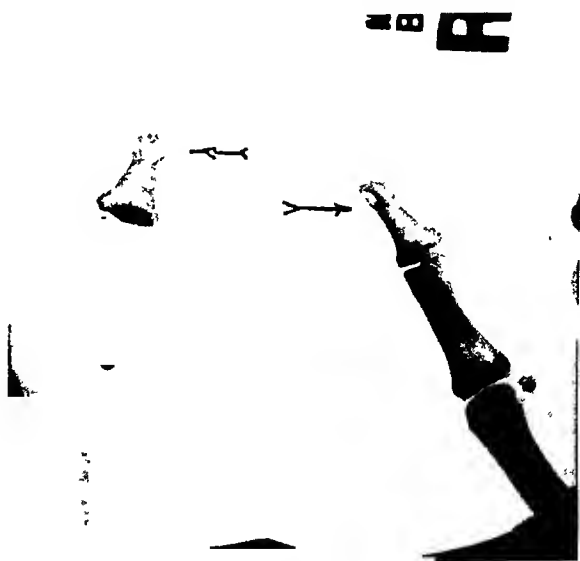


Fig. 1. Small round-cell sarcoma resembling Ewing's tumor, occurring as a subungual lesion.



in the hand, usually occur in the carpal or metacarpal bones. One of the lesions was multiple, involving the phalanx of the left thumb and the phalanx of the left index finger. The duration of the symptoms of the earliest case was seven days and of the

oldest twenty-eight years. The commonest symptom in 24 cases was either tumor alone or tumor associated with trauma. Pathologic fracture was noted in two cases. The remaining cases gave some history of trauma.

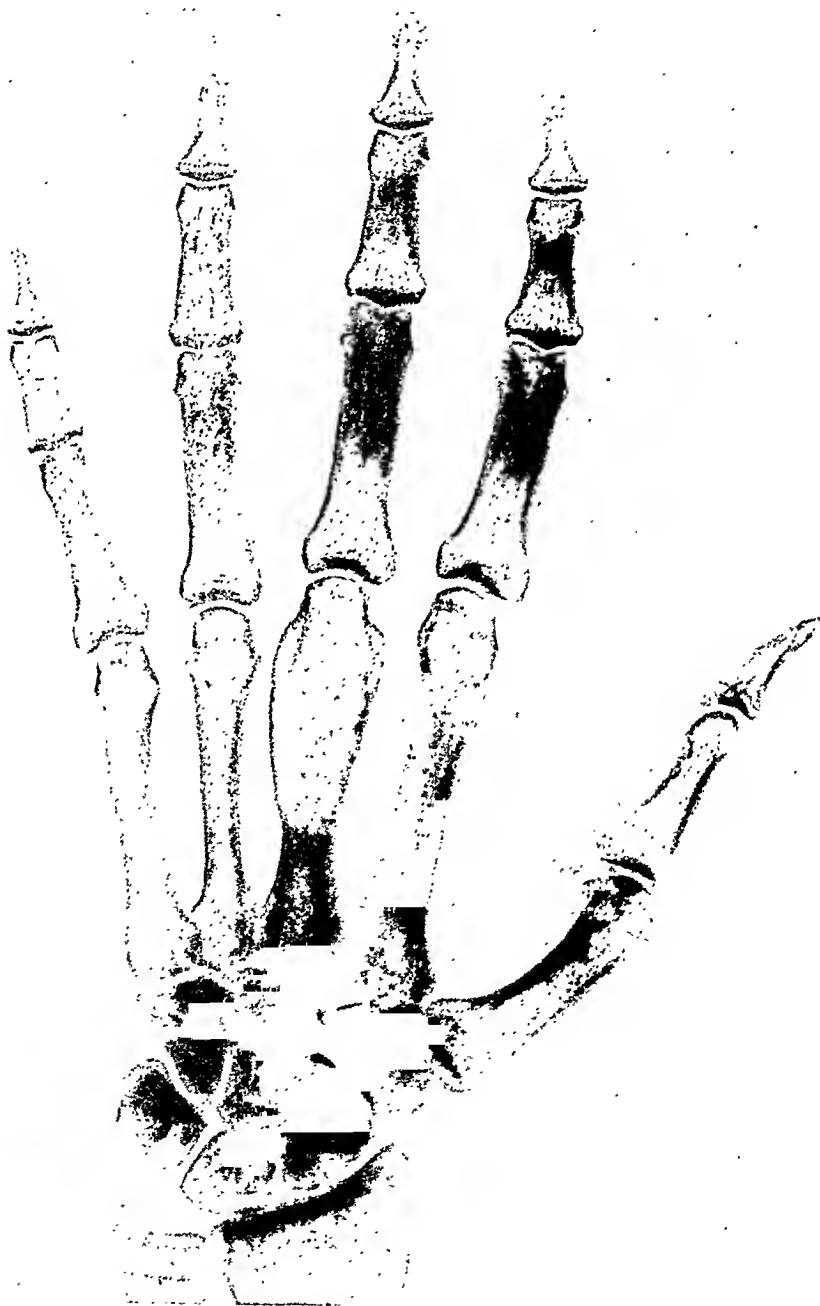


Fig. 2. Chondromyxoma in a metacarpal bone showing the central bone-destructive character and very fine trabeculation. Bone cysts or giant-cell tumors also occur in this region, but are more coarsely and definitely trabeculated. (Cf. Fig. 3.)



Fig. 3. Bone cyst occurring in the proximal phalanx of a big toe.

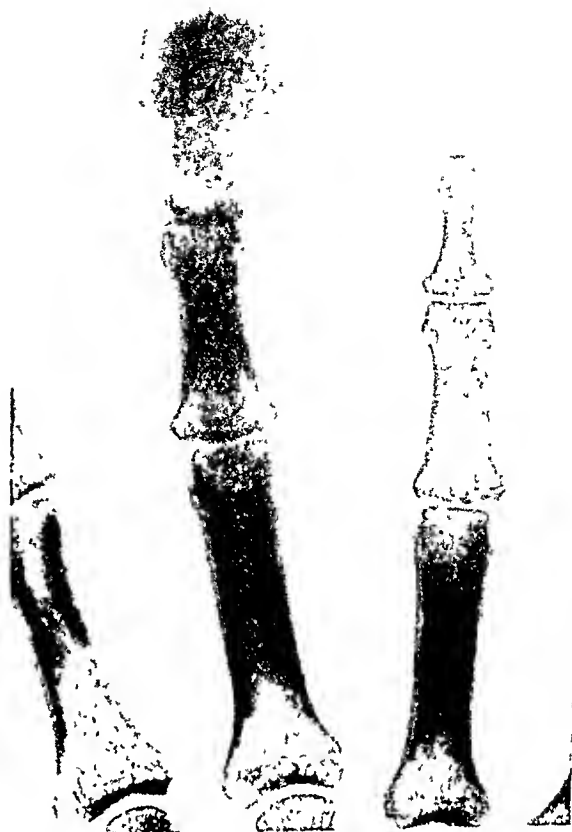


Fig. 4. Giant-cell tumor of a distal phalanx showing advanced bone destruction.

The X-ray findings are usually those of a single, central, expanded rarefied or translucent area, but occasionally there may be multiple areas. Seldom is there new bone formation. The treatment consists either of curettement, amputation, or excision. Two cases of our group were irradiated. The majority of patients upon whom operation was done were discharged well. Of the two cases irradiated, some improvement was noted in one, while the other was unimproved. The microscopic findings consisted chiefly of fetal cartilage and myxoma. In some, there was adult and calcifying cartilage. It was thought advisable to classify these tumors as chondromyxomas, since they frequently contain both cartilage and myxomatous tissue. In an earlier study

we separated these tumors and divided them into chondromas and myxomas.

#### GIANT-CELL TUMORS

There were twelve cases of giant-cell tumor, the youngest patient being ten years of age and the oldest sixty years. Pain, trauma, and tumor were the commonest symptoms and varied in duration from six months to thirteen years. The X-ray findings revealed a bone shell, with expansion, usually without trabeculation. In these tumors the bone shell may be either intact or perforated. The treatment consisted of irradiation in one case; in the others, resort was had to either excision, curettement, section, or amputation. The mi

findings consisted of a spindle-cell stroma containing many large multinucleated giant cells. Practically all patients were well five to ten years later.

### CYSTS

There were nine cases of osteitis fibrosa, the youngest patient being four years of age and the oldest fifty-one. The chief symptoms were trauma and tumor, and the duration was from four months to five years. The X-ray revealed a small cyst, with some bone expansion and trabeculation. The differential diagnosis between giant-cell tumor and osteitis fibrosa is rather difficult, but usually the bone expansion is not quite so marked and the trabeculation is more evident in a cyst. The treatment consisted either of curettement, excision, resection, or amputation. Practically all patients were well from one to eight years.

### XANTHOMA

There were twenty cases of xanthoma involving the tendons and joints of the small bones of the hands and feet. There is no characteristic X-ray picture of this condition. The microscopic findings are usually those of typical giant-cell areas in the tendons connected with the joints. Geschickter and Copeland have described this condition in detail (2).

### SARCOMA

There were three cases of sarcoma, two of the feet and one of the hand. One case under observation by Dr. George H. Hess is of especial interest, and a brief abstract of the history of this case follows. The patient was a boy, fifteen years of age, who had injured his foot two months before the first examination (on September 8, 1927), while jumping. At the time of this examination there was a hard, non-painful,

non-inflammatory tumor mass about the size of a walnut in the region of the base of the second metatarsal bone. This was removed and films and slides sent to Dr. Bloodgood, who reported sarcoma. The local pathologist diagnosed it as a small round-cell sarcoma. The patient had no recurrence at the site of operation at the time of admission into the hospital in July, 1928. His chief complaint at this time was weakness, shortness of breath, and a cough which had begun about five weeks previously. At this time the entire right chest was flat, with the heart sound displaced to the left. Aspiration of the chest showed a large quantity of sterile bloody fluid. The urine and blood counts were normal. The temperature ranged between 100° and 103°; pulse 120; respirations 36. X-ray films of the lungs made at this time showed metastatic sarcoma, there being circumscribed areas of density scattered throughout. The patient died about September 1, 1928.

### CARCINOMA

There were six cases of carcinomatous metastases to the skeleton involving also bones of the hands or feet. The diagnosis in these cases was always easily made on the basis of the other lesions present in the bones of the trunk or of the extremities, for in no case was metastatic involvement of the small bones observed, unless a generalized skeletal metastasis was present.

### CONCLUSION

This study emphasizes the rarity of malignant lesions in the small bones of the hands and feet. If the lesion is single in character and central and osteolytic in type, malignancy can practically be ruled out on the basis of the X-ray examination. Periosteal, osteogenic sarcoma occurring as a single lesion in the small bones of the extremities is rare. It is found in about 2 per

cent of the cases and is difficult to differentiate in the roentgenogram from the more frequent lesion of ossifying periostitis. The usual tumor encountered in the bones of the hands or feet contains cartilage and is either an exostosis or a chondromyxoma, both of which can be safely treated as benign. Most of the remaining tumors are of the giant-cell group, or the pathologically closely related lesions of osteitis fibrosa or xanthoma, which also are typically benign. When metastatic nodules occur in the small

bones, their nature may be readily discerned by the presence of diffuse involvement of the remainder of the skeleton, which is always associated with their presence in the small bones.

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# CENTRAL TUMORS OF THE LOWER JAW

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**I**N the X-ray diagnosis of bone tumors it is as important to realize the limitations of the X-ray as it is to recognize those diagnostic characteristics which the film reveals. With the aid of the X-ray the central bone-expansive tumors of the lower jaw can be differentiated from periosteal lesions and osteomyelitis. But central bone-destructive tumors of the jaw include (1) the root or

finding in a routine X-ray examination of the teeth is the presence of periapical areas of bone absorption about non-vital teeth whose apices may be more or less eroded (Figs 1 and 2). This characteristic picture of a locally symptomless lesion is usually called a root or alveolar abscess. If, however, the tooth be extracted, no pus, but, rather, a granuloma or sometimes a root

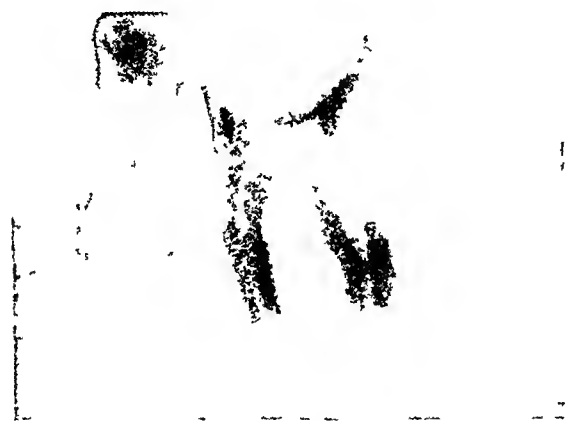


Fig 1 Roentgenogram showing an area of bone absorption about a carious molar. An alveolar abscess. (Dr Kahn's case)

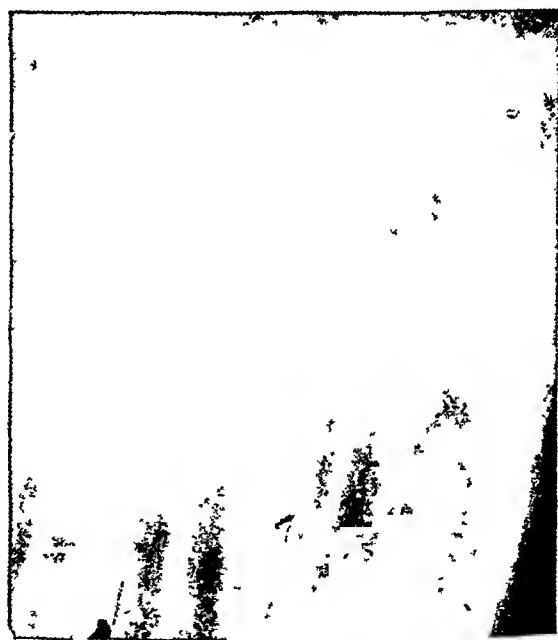


Fig 2 Roentgenogram showing an area of bone absorption with a sclerosed wall about the first upper molar. This is a chronic abscess or granuloma. (Dr Kahn's case)

alveolar abscess, (2) its derivatives—the granuloma and root cyst, (3) the dentigerous cyst, (4) the adamantine epithelioma, (5) the giant-cell tumor, (6) the fibroma and fibrosarcoma, and (7) rarer lesions such as carcinoma arising from the gums, and myxoma. After recognizing a lesion as central, further identification is sometimes difficult. This problem of differential diagnosis is the topic of the following pages, based on a study of the jaw tumors in the Surgical Pathological Laboratory of the Johns Hopkins Hospital.

*The root abscess*—The most frequent

cyst will be found. The granuloma is the sequel of an acute apical peridontitis in which the intense inflammation has subsided, with the formation of a nodule of chronic granulation tissue. Strands of squamous epithelium, arising from the irritated epithelial rests remaining about the tooth root, are a frequent finding in microscopic sec-



Fig. 3. Photomicrograph of a dental root cyst showing the epithelial lining. To one side lies the chronic granulation tissue found in granulomas. Path. No. 39,578.

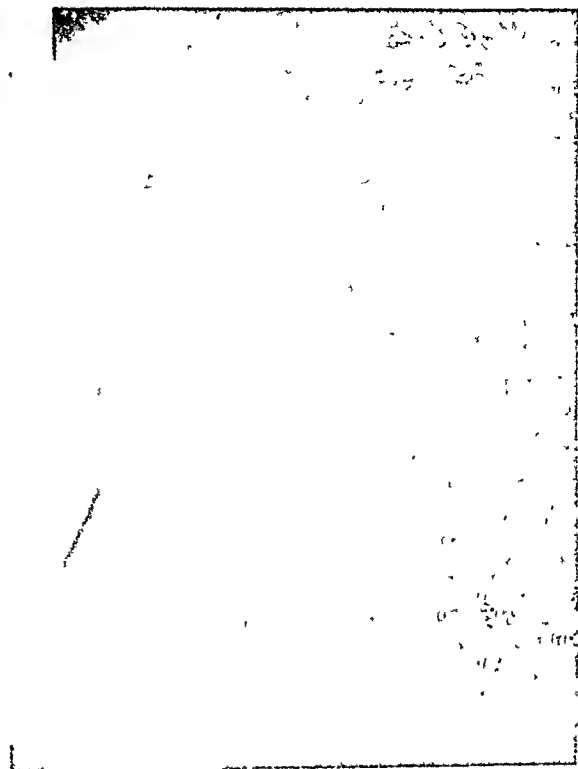


Fig. 4. Roentgenogram of a central lesion one year after the bicuspid and molar had been extracted because they were loose. Sections showed squamous-cell carcinoma. Path. No. 29,600.

tions of such a granuloma. When cystic degeneration occurs in these epithelial sprouts a dental cyst lined by stratified squamous epithelium is the result (Fig. 3). The granuloma is of small size, while the root cyst may grow by continuous desquamation of epithelial cells and expand the jaw bone to such an extent that parchment crepitation may be elicited on pressure. The recognition of the so-called root abscess is most important, not only because root abscesses may give rise to osteomyelitis or act as foci of infection in various chronic conditions but because early malignancy must be excluded. The roentgenogram of a root abscess is quite characteristic. When, however, the film shows an atypical area more films should be taken for further study, and, upon extraction of the tooth, sections should be made from tissue adherent to the tooth or from the root socket. It should be unnecessary to note that teeth should not be extracted without first taking X-ray films. This laboratory contains many

cases of tooth extraction in early malignancy performed with the hope of relieving local symptoms in which either no X-ray has been made or else it has been incorrectly diagnosed as a root abscess. In these early cases the X-ray, supplemented by the microscope, performs an invaluable service.

A case history (Path. No. 29,600) may illustrate the above point. The patient, a white male aged 50, was a heavy smoker and carried a few patches of leukoplakia in his mouth. He complained of looseness of a molar and two bicuspid, which were examined by the X-ray. The film was interpreted as an abscess, the teeth extracted, and no tissue was saved. A year later the patient sought relief for pain and swelling of the jaw. The X-ray film (Fig. 4) taken at this time was thought to be that of a root cyst. At operation, no cyst was found and tissue from the cavity, sent to this laboratory, was

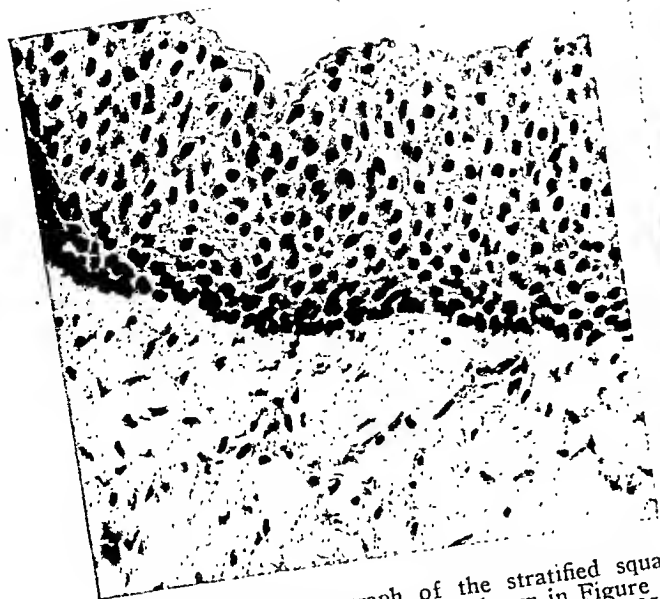


Fig. 5. Photomicrograph of the stratified squamous epithelial lining of the cyst shown in Figure 3. Note the desquamating epithelial cells. Path. No. 39,578.



Fig. 6. High-power photomicrograph of a polycystic recurrent adamantinoma. The cystic degeneration in the stellate reticulum and the peripheral tall columnar cells are shown. Path. No. 17,524.

diagnosed as squamous-cell carcinoma. Caution, resection of the jaw, and radium failed to save the patient. This is an example of the manner in which squamous-cell carcinoma of the gum following a leukoplakia may grow down along the side of the tooth and produce the local symptom of a loose tooth, finally invading the marrow cavity of the jaw.

When the X-ray film shows a central bone-destructive lesion of three or more centimeters in diameter so that neighboring tooth roots are involved, an X-ray diagnosis becomes difficult, as such a lesion may be a growing dental root cyst, a dentigerous cyst, a central fibroma or sarcoma, a giant-cell tumor, or even a squamous-cell carcinoma originating from the mucous membrane. The history is of importance. The common story of a painless, slow growing swelling situated near the angle of the jaw, in a patient in the third decade of life, enables one to exclude those tumors of rapid growth, but still does not establish the diagnosis. The findings on examination—the size, form, character on palpation, parchment

crepitation, a chronic draining sinus with perhaps enlarged submental and submaxillary glands—all these are of no absolute diagnostic value. The various possible diagnoses of such a central lesion are discussed in their order of frequency as determined by our case histories.

*The dental root cyst.*—The dental root cyst, next to the granuloma, is the most frequent lesion. It arises from a granuloma in which epithelial strands have undergone a cystic degeneration. This cyst slowly increases in size by a desquamation of the stratified squamous epithelium lining the cyst wall (Fig. 5). The root cyst may arise at any age, and most frequently about the bicuspid and molars. It is a slow growing tumor, usually painless, distending the alveolar process in a half sphere about the root tip. The mucous membrane is normal. Depending upon the degree of bone distention, the swelling will be bony hard, upon further distention elastic, giving rise to parchment crepitation or even fluctuation. An elastic wall may become firm due to new bone formation. Occasionally the cyst will

expand along the jaw and marrow cavity and finally occupy the greater part of the jaw. A granuloma left behind in the jaw after a tooth extraction sometimes develops into a root cyst, offering thereby a lesion difficult to diagnose. When a cyst is found at operation the solid central tumors are excluded, but the lesion can be identified with certainty only by the microscope, which shows a cyst lining of stratified squamous epithelium. This lining should be stripped from the cyst wall. No further treatment is necessary.

*Adamantine epithelioma.*—The next most frequent lesion of our series is the adamantine epithelioma (38 cases). This tumor is a true neoplasm arising from the enamel organ, its favorite site being in the neighborhood of the molars, an area which is also a site of predilection for dentigerous cysts and giant-cell tumors. The age at which adamantinoma arises roughly corresponds to the time of second dentition, i.e., between fifteen and twenty-five years. Because of its slow, painless growth the patient may not notice any swelling for a long time. In our series there are seven cases in which fifteen or more years had elapsed between the first recognition of the tumor and the patient's appeal for medical aid. Sometimes after a long slow growth a sudden increase in size of the tumor brings the patient to the physician.

Microscopically a characteristic picture is found: lying in a fibrous stroma are epithelial strands, morphologically similar to the early enamel organ, showing a peripheral layer of tall columnar cells with nuclei basally situated and an adjoining layer of transitional cells enclosing a stellate reticulum in which cystic degeneration is frequently found (Fig. 6). In the gross the tumor is solid, with small cystic areas, or else mono- or polycystic (Fig. 7). On section, the solid tumor presents white friable areas traversed by fibrous septa enclosing cysts of varying size.



Fig. 7. A gross specimen from a polycystic adamantinoma showing two large cavities and numerous smaller cysts. Path. No. 31,404.

The X-ray film shows a central expansive lesion of clearly demarcated outlines (Fig. 8). All polycystic lesions are not, as is generally supposed, adamantine epitheliomas (Fig. 9): the trabeculation found in the giant-cell tumor and large root cyst may simulate this polycystic appearance. The solid or monocystic adamantinoma can not be differentiated from other central tumors by the X-ray.

The adamantine epitheliomas are characterized by their tendency to recur when incompletely removed—18 of our 38 cases are recurrent. Four patients have died of the tumor. When left alone, the tumors never metastasize but ultimately cause great destruction of the jaw by distention. The large number of recurrences in our series is evidence that simple curettage frequently fails to remove all of the tumor. Moreover, the inadequacy of even a complete resection of the jaw in several cases of repeated recurrences stresses the necessity of effective primary treatment. Bloodgood (1) reports the case of an adamantinoma at the angle of the lower jaw (Fig. 10) in which chemical cautery was used with success. The



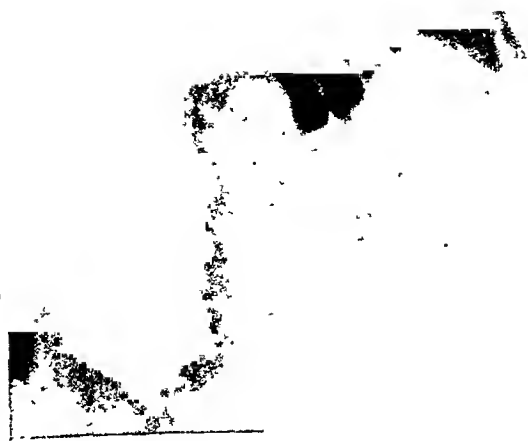


Fig. 8. Roentgenogram of an adamantinoma arising in the anterior third of the jaw. The teeth had been pulled three years previously without any decrease in the swelling. Path. No. 36,356.

continuity of the jaw was preserved and the facial deformity is scarcely noticeable. The patient has now been well for nine years. The lesion was a single cyst. This same procedure was successful in two other cases of monocystic adamantinoma. In polycystic tumors it is impossible to reach with cautery all the recesses in which invasion may have occurred, and resection is indicated. When the polycystic lesion has expanded the jaw bone to a thin shell, the preservation of continuity by leaving a bridge of bone ought not to be attempted. As Lewis (2) has pointed out, recurrence almost invariably takes place in that bridge of bone.

There is no evidence to show that either the X-ray or radium is of benefit in the treatment of adamantine epithelioma.

*Dentigerous cyst.*—The dentigerous cyst, a cystic degeneration of the enamel organ, occurs much less frequently than the root cyst. Partsch (3), in a series of cases collected during a period of twenty years, found 394 dental root cysts and 13 dentigerous cysts, a ratio of 30 to 1. The dentiger-

ous cyst arises early in the development of the tooth germ. That tooth corresponding to the abortive enamel organ fails to erupt, leaving a vacant space in the alveolus. As in the adamantinoma, the site of the molar teeth is the one of predilection. The growth is the same as that of the root cyst and adamantinoma, *i.e.*, slow and painless, gradually distending the jaw. The X-ray reveals the non-erupted tooth, varying in size from a bit of enamel to a fully developed crown lying within the cyst cavity (Fig. 11). A non-erupted tooth in a large cyst does not exclude a giant-cell tumor or adamantinoma (see Fig. 9). The pathology at operation, and frozen section if necessary, will establish a diagnosis. The cyst is lined with stratified squamous epithelium identical with that found in root cysts. The dentigerous cysts need not be cauterized. The cyst should be stripped of its epithelial lining.

*Giant-cell tumor.*—Next in frequency occurs the giant-cell tumor. Geschickter and Copeland (4) have shown the relation of the giant-cell tumor to cartilaginous bone and how in the lower jaw giant-cell tumors arise from remains of Meckel's cartilage, *i.e.*, at the symphysis and at the angle of the jaw. Of the fourteen giant-cell tumors in their series, nine were situated at the symphysis, three in the ascending ramus, and two were of undetermined origin. This tumor is of rapid growth—seven months is the average duration, although one patient carried the tumor for three years. The age incidence is greatest in the second decade; eleven patients were under twenty-three years of age, and only three over thirty. This is most curious, since giant-cell tumors of the long bones are found in patients over twenty-five years of age.

The X-ray film shows a central, clearly demarcated, bone-expansive lesion which, when large, reveals trabeculation (Fig. 12). Since most patients are young, non-erupted



Fig. 9. Roentgenogram of a dental root cyst. Note the polycystic appearance of the lesion. The tooth had been extracted, with no relief of symptoms. Path. No. 30,810.

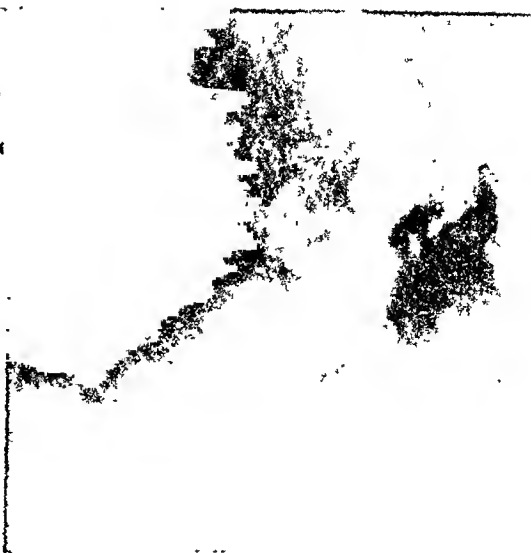


Fig. 10. Roentgenogram of an adamantinoma at the angle of the jaw expanding the ascending ramus to such thinness that the clasps cannot be seen in the film although they could be palpated. Note the molar tooth which the tumor has overridden. Path. No. 27,596.

teeth are a frequent finding. This often leads to an X-ray diagnosis of dentigerous cyst. While the X-ray appearance is not distinctive, the rapid growth of the tumor should suggest giant-cell tumor. The pathology at operation—a red, friable, hemorrhagic tissue—is further evidence of giant-cell tumor, but a frozen section should be made, since occasionally adamantine epithelium may resemble giant-cell tissue.

In the treatment of giant-cell tumor, Bloodgood (1) advises resection when complete removal of the bone involved does not interfere with function. Otherwise, thorough curettage followed by chemical cautery should be performed. The chemical cautery consists of phenol followed by alcohol and then by a 50 per cent solution of zinc chloride. Resection of the jaw is unnecessary and mutilating.<sup>1</sup>

*Central fibromas.*—Central fibromas are comparatively rare lesions; there are only six verified examples in this laboratory. The growth is slow and gradual, although sud-

den increase in size may occur. Usually there is no pain. The patients are young adults—twenty-five is the average age, fifteen and thirty-eight the extremes. The swelling is of a duration varying from one to fifteen years. One case showed bilateral

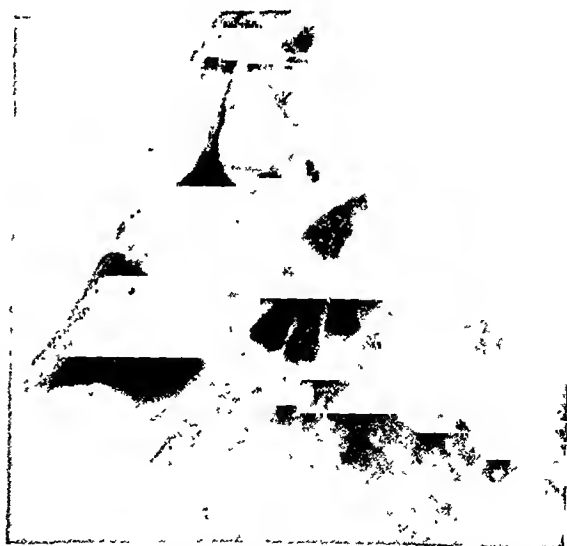


Fig. 11. Roentgenogram of a dentigerous cyst showing a tooth lying within a central cavity. (Dr. Kahn's case.)

<sup>1</sup>While X-ray therapy of giant-cell tumors of the long bones has its definite sphere of usefulness, in giant-cell tumors of the jaw, because of the difficulty in diagnosis, X-ray therapy has a limited scope.



Fig. 12. Roentgenogram of a giant-cell tumor at the angle of the lower jaw. The patient's age is 12, hence the unerupted teeth. Path. No. 36,750.



Fig. 13. Roentgenogram of a central fibroma of the lower jaw. This diagnosis was made only at operation by the aid of frozen sections. Path. No. 42,680.

swelling which had persisted for twelve years, since the age of three. Palpation reveals nothing of differential value.

The X-ray film shows a central expansive lesion of clear outlines, not characteristic (Fig. 13). In one case trabeculation was noted. The operator must be prepared to make the diagnosis from the gross appearance and frozen sections. Microscopically these central fibrous tumors vary from purely fibrous to fibrosarcomatous structures. In one central fibroma the recurrence was a spindle-cell sarcoma, and metastases, with death, followed the original curettage. This instance emphasizes the necessity of thermal and chemical cauterization of the cavity from which these tumors can be shelled.

*Rare lesions.*—New (5) reports bone cysts at the angle of the jaw, filled with a "cooked oatmeal-like" material, without an epithelial lining and of unknown etiology. They are quite benign. We have no examples of such cases. In multiple osteitis fibrosa cases of jaw involvement have been reported. There is one instance in our laboratory of a central myxoma which grew

out of a tooth socket following extraction for pain. The X-ray films made before the extraction were negative. A section of the outgrowth showed myxoma. Radium packs were applied, followed by a curettage and cautery, with no recurrence to date (18 months). Multiple myeloma has not been observed in the lower jaw. We have one case of metastatic carcinoma involving the jaw. The rare odontoma, a solid tumor composed of varying proportions of dentin, enamel, and cementum, affecting the molars in the region of the-submaxillary angle, can be recognized in the X-ray film as solid. The tumor is quite benign and can be shelled out of its capsule.

*Osteomyelitis.*—In old root cysts, dentigerous cysts and adamantinomas which have expanded the jaw bone to paper-thin size, a rupture of the cyst wall, with chronic discharge into the mouth, is not an infrequent occurrence. At times the resulting infection of the tumor gives rise to an acute osteomyelitis, complicating the original condition. In three cases of adamantine epithelioma, osteomyelitis was the clinical and X-ray diagnosis, but the findings at operation, verified

microscopically, established a correct diagnosis and procedure.

#### SUMMARY

Tumors of the lower jaw are shown by the X-ray to be either central or periosteal. Of the central tumors, the dental root abscess, granuloma, and small root cyst—as well as the small dentigerous cyst because of its contained tooth—can be identified with certainty. Atypical lesions should be studied microscopically to exclude early malignancy. Monocystic lesions larger than three centimeters cannot be diagnosed differentially by the X-ray. Only the findings at operation, verified by the frozen section, can establish the pathology. A polycystic appearance is produced by any of the central tumors, but most often by the adamantinoma and giant-cell tumor.

The dental root cyst and dentigerous cyst are treated by excision, with stripping of the epithelial lining from the cyst wall. Giant-cell tumor and the monocystic adamantinoma are attacked with chemical cautery. Polycystic adamantinomas should be resected. The bone cavity left by a central fibroma must be treated with chemical and thermal cautery.

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# LESIONS OF THE UPPER HUMERUS

By ROBERT C. MAJOR, BALTIMORE, MARYLAND

From the Surgical Pathological Laboratory of the Johns Hopkins Hospital and University

**T**UMORS of bone occurring in the upper end of the humerus offer to surgeon and patient distinct advantages for early diagnosis and effective treatment. These advantages are derived from the ready palpability of a tumor in this location, its accessibility to surgery, and the possibility, in malignant disease, of combining radi-

site for exostoses, bone cysts, and, among the malignancies, chondrosarcoma and metastatic carcinoma. The tumors arising from pre-cartilaginous and pre-osseous connective tissue or in connection with the growth of cartilage, both benign and malignant, predominate.

Primitive connective tissue, capable of



Fig. 1. Benign exostosis. An osteochondroma showing a broad base of normal bone, with a cartilaginous cap of exceptionally large proportions, the cap containing calcareous and bony trabeculae. Path. No. 12,770.

cal procedure with a fair plastic and functional result, that is, resection with subsequent bone graft. Resection of the upper end of the humerus offers as much in the treatment of malignant tumors as does amputation.

The upper humerus is an occasional site for all common bone tumors and a favorite

forming both cartilage and bone, may give rise to benign and malignant tumors. Moreover, the benign tumors of such origin may undergo malignant change. Cartilage and bone formation characterize these tumors and bone destruction is prominent only in advanced malignant cases. The benign members of the group are exostosis and



Fig. 2-A. Chondrosarcoma (primary). Roentgenogram before operation. Note the fuzzy, infiltrating outer margin and the fine multilocular appearance within the tumor. The destruction of the cortex is apparent. Path. No. 40,690.

chondroma; the malignant, chondrosarcoma and the sclerosing type of osteogenic sarcoma. In the upper humerus, chondrosarcoma is by far the most important of these. This tumor, while occurring with slightly greater frequency in the upper tibia, constitutes 29 per cent of the malignant lesions of the upper humerus.

Exostosis is readily identified in the X-ray film by its base, or pedicle, of normal bone projecting through a gap in the periosteum and surmounted by a cartilaginous cap. This condition arises usually between the ages of ten and twenty-five and is most frequently found in the ends of the long bones at the site of a tendon attachment. It is common in the upper humerus. Occasionally, multiple exostoses occur as manifestations of an hereditary congenital bone disease which also produces bending of the bones and other skeletal deformities. These multiple congenital tumors should not be excised until the growth period is ended. Both the single and the multiple type may give rise to secondary chondrosarcoma.

Chondroma, or chondromyxoma, a benign tumor usually occurring in the small bones of the hands or feet, is rare in the long bones. Two cases of benign chondroma in



Fig. 2-B. Roentgenogram of same case shown in Figure 2-A, after operation. The upper third of the humerus has been resected. A recurrence has taken place two years after operation.

the upper humerus and five cases of secondary chondrosarcoma arising in chondroma are recorded in this laboratory. In the X-ray film, this tumor is apt to appear as a finely multilocular, translucent shadow beneath the cortex. The common age incidence for benign chondroma is between twenty and thirty.

Chondrosarcoma may be a primary malignant tumor or, as has been stated, a malignant tumor secondary to a benign exostosis or chondroma. Of our cases, 28 per cent were primary and 72 per cent, secondary. The primary type most frequently appears between the ages of fourteen and twenty-one years; the secondary, after thirty-five. The onset of malignancy in secondary chondrosarcoma is marked by rapid increase in size and beginning pain. In the X-ray film,



Fig 3-A Chondrosarcoma (secondary to benign chondroma) Roentgenogram showing medullary destruction and pathologic fracture, which are almost wholly obscured by the tremendous soft-part shadow Path No 42 888

one sees a more or less translucent, sub-cortical shadow with fuzzy, infiltrating outer margin. Like the benign chondroma, chondrosarcoma may be finely multilocular. The shadows of spicules of new bone may be present. Later in its course, this tumor destructively involves the cortex of the bone. The clinical course of the primary form ends usually within twenty months, while that of the secondary form extends over a much longer period.

The sclerosing, or osteoblastic, type of osteogenic sarcoma occurs in the metaphyses of the long bones of patients between fifteen and twenty-five years of age, rarely, however, in the proximal metaphysis of the humerus. There are only three such cases in this laboratory. The X-ray film is characteristic—dense, radiating, periosteal new



Fig 3-B Gross specimen of the same tumor shown in Figure 3-A. The invasion of the marrow cavity is apparent, and the multiloculated and cystic character of the soft-part tumor is clearly shown.

bone ("sun ray type") and sclerosis of the marrow cavity by infiltration from the periosteal zone. Trauma usually precedes and pain accompanies these tumors, the duration of whose symptoms averages ten months.

Two additional bone-formative processes occur in the region of the humerus, but rarely. They are ossifying periostitis and myositis ossificans: the first being an affection of bone, the second, entirely separate from bone.

Ossifying periostitis is due to infection which produces thickening and increased density of cortical bone, with a consequent tendency toward obliteration of the medullary canal, and varying amounts of periosteal roughening and new bone formation.

This condition is usually found in individuals under twenty-five years of age, confined to a single bone—the tibia. The onset is

of eighteen, and the almost total absence of symptoms until pathologic fracture occurs.

Giant-cell tumors are relatively infrequent

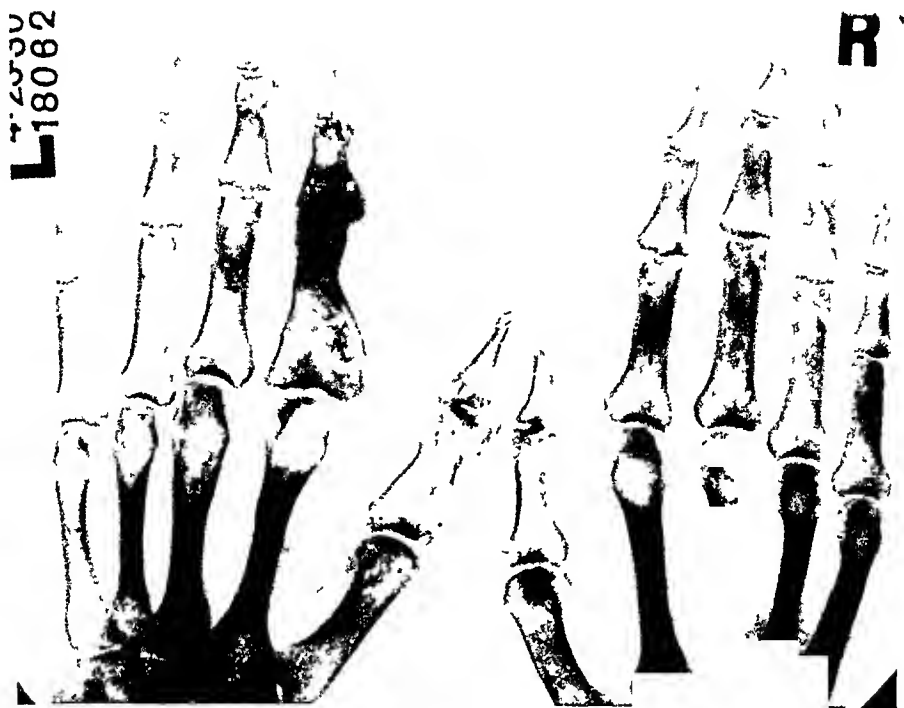


Fig 3-C. Multiple benign chondromas, left thumb and forefinger, present in the same patient shown in Figures 3-A and 3-B.

acute, with subsequent abatement of symptoms.

Myositis ossificans, which sometimes follows hemorrhage into muscle, may be distinguished from a true lesion of bone by a zone of non-osseous tissue separating tumor and bone, visible in the X-ray film.

Of the tumors which, in the X-ray film, present bone destruction as their chief characteristic, all are central, and, with the exception of the chondroblastic sarcoma, all exhibit a strong tendency toward pathologic fracture.

Bone cysts, of which the upper humerus is the second most frequent site, is to be distinguished by the smooth, symmetrical expansion and thinning of the cortex (which is usually left intact), the metaphyseal location, the occurrence usually before the age

in the upper humerus. The location in the epiphysis, the age of the patient (generally over twenty-five), the asymmetrical expansion with frequent perforation of the bone shell, and the usual sequence of trauma, pain, tumor, and pathologic fracture, help to identify these tumors.

Chondroblastic sarcoma, a rare tumor in any location, has occurred in the upper humerus in four cases from this laboratory. The lesion, in the region of the epiphyseal line, produces mottled, central bone destruction, with or without cortical expansion, and a definite periosteal reaction. The age of the patient is most frequently between ten and twenty. The chondroblastic sarcoma is a highly malignant tumor, two of thirty cases living five years with surgical and X-ray treatment.



The osteolytic osteogenic sarcoma is a type much more frequently encountered in the upper humerus than the sclerosing osteo-

tumor, exhibiting central "punched-out" areas and frequent pathologic fracture in the X-ray film. Of the cases in the files of



Fig 4-A Chondrosarcoma (probably secondary to benign chondroma). Roentgenogram of the upper humerus (taken following injury), with clinical diagnosis of a pathologic fracture. Note the widened metaphysis and trabeculated structure of a chondroma. Path. No. 43,604



Fig. 4-B. Roentgenogram of the same patient shown in Figure 4-A thirteen months later showing extensive and progressive destruction, with involvement of the periosteum pointing to a secondary malignant change at the site of the original cartilaginous lesion

genic sarcoma, as evidenced by the accompanying table. It is a tumor primarily of young adults and grows increasingly rare with advancing age. In the X-ray film there is central bone destruction involving the cortex, but without cortical expansion, and a definite periosteal reaction, which, however, does not parallel the "sun ray" effect produced by the sclerosing type.

Multiple myeloma affected the upper end of the humerus in 37.5 per cent of the cases which involved any of the long bones. Its occurrence there is always indicative of a general skeletal involvement. It is a multiple

this laboratory, there was pathologic fracture in 62 per cent. The age and clinical features are peculiarly helpful in diagnosis. The occurrence of multiple myeloma usually in the sixth decade of life and the Bence-Jones bodies in the urine, skeletal deformities, and neurological manifestations fairly characteristic.

Metastatic tumors, including carcinoma and hypernephroma, are common occurrences in especially when there is metastatic lesion. Histology constitutes the chief primary



Fig. 5. Benign bone cyst. Roentgenogram of a benign bone cyst situated in the metaphysis, with smooth symmetrical expansion, thinning of cortex, and pathologic fracture.



Fig. 6-A. Benign giant-cell tumor. Roentgenogram shows the central location in the epiphysis and the asymmetrical expansion typical of these lesions. Path. No. 28,636.

osteolytic metastases from breast carcinoma are more frequent in the spine and pelvis but are not rare in the upper humerus and region of the shoulder girdle, particularly in cases in which surgical treatment has been delayed. The diffuse osteoplastic metastases of carcinoma of the prostate rarely include the upper humerus in their distribution. The age of the patient, usually late adult life, and the demonstration of a primary malignant tumor in another location, are all important diagnostic points.

The bone destruction seen in cases of Ewing's tumor and periosteal fibrosarcoma is a secondary process. These tumors are rarely seen in the location being discussed. Ewing's tumor is characterized by its intra-cortical origin, with parallel endosteal and subperiosteal layers of new bone formation ("onion-peel appearance"), and occasional right-angled periosteal bone formation. Peri-



Fig. 6-B. Gross specimen of the tumor shown in Figure 6-A, demonstrating the perforation of the bone shell.



Fig. 7. Chondroblastic sarcoma. In the roentgenogram the location near an epiphyseal line, the mottled central bone destruction, and the periosteal involvement are typical. Path. No. 35,088



Fig. 8. Metastatic hypernephroma. Roentgenogram shows a single destructive lesion, with absence of bone formation. The shell of the bone has been perforated and the tumor has extended into the soft parts; it has also reached the epiphysis. Path. No. 42,906.

L 18491  
3 11 30



Fig. 9. Metastatic carcinoma of the prostate. Roentgenogram shows the diffuse osteosclerosis caused by metastatic carcinoma from the prostate invading the epiphysis and metaphysis of the upper humerus. Path. No. 42,182.

osteal fibrosarcoma, in the X-ray film, presents a soft-part shadow, secondarily eroding the bone beneath, and sometimes slight reactive new bone formation. Two-thirds of all the cases in this laboratory are found in patients thirty years of age or older.

These brief outlines of X-ray findings and clinical features in the lesions of the upper humerus bring out, it is hoped, certain rather definite points of differentiation.

As regards treatment of these lesions of the upper humerus, the following are important points:

1. The two most frequent osteolytic lesions do not require surgical intervention. They are the benign bone cyst and the non-metastatic tumor, where as in the metastatic tumor, where as in the defect c

cyst is best left alone, or, if pathologic fracture has occurred, given light X-ray therapy. The metastatic tumor is treated best in this late stage by heavy doses of deep X-ray.

2. In all other cases in which the nature of the tumor is doubtful, the wise procedure seems to be to put the arm at rest, administer X-ray therapy, and obtain competent consultation on the X-ray films, rather than immediate exploration for microscopic examination.

3. Resection in all malignant lesions of

the upper humerus offers as much for cure as does amputation and more for the patient, if cured.

Table I summarizes data obtained from analysis of the cases of upper humeral lesions from the Surgical Pathological Laboratory of the Johns Hopkins Hospital. Sclerosing osteogenic sarcoma and chondrosarcoma have been grouped together as periosteal sarcoma; osteolytic osteogenic and chondroblastic sarcoma, as central osteolytic sarcoma.

TABLE I

| Tumor                         | No. cases occurring in upper humerus | Most frequent site in long bones | Total no. cases occurring in long bones | Percentage of total no. cases in long bones occurring in upper humerus |
|-------------------------------|--------------------------------------|----------------------------------|---|--|
| Exostosis                     | 22                                   | Lower femur                      | 181                                     | 12.2   |
| Chondroma                     | 2                                    | Upper humerus<br>Lower femur     | 7                                       | 28.5   |
| Bone cyst                     | 32                                   | Upper femur                      | 135                                     | 23.7   |
| Giant-cell tumor              | 9                                    | Lower radius                     | 145                                     | 6.2  |
| Periosteal sarcoma            | 21                                   | Upper tibia                      | 128                                     | 16.4   |
| Chondrosarcoma                | 18                                   |                                  |   |  |
| Sclerosing osteogenic sarcoma | 3                                    |                                  |   |  |
| Osteolytic sarcoma            | 17                                   | Lower femur                      | 106                                     | 16.0   |
| Osteolytic osteogenic sarcoma | 13                                   |                                  |   |  |
| Chondroblastic sarcoma        | 1                                    |                                  |   |  |
| Fibrosarcoma                  | 1                                    | Upper tibia                      | 13                                      | 7.7  |
| Ewing's tumor                 | 2                                    | Upper femur                      | 56                                      | 3.6  |
| Multiple myeloma              | 6                                    | Upper femur                      | 16                                      | 37.5   |
| Metastatic tumor              | 15                                   | Upper femur                      | 96                                      | 15.6   |
| Ossifying periostitis         | 6                                    | Upper femur                      | 75                                      | 8.0  |
| Myositis ossificans           | 1                                    | Upper femur                      | 20                                      | 5.0  |
|                               | 134                                  |                                  | 975                                     |  |

Total malignant lesions..... 62  
 Total benign lesions..... 72  
 Percentage malignant ..... 46

## TUMORS OF THE OS CALCIS

By JOHN R. MOORE, M.D., Shriners' Hospital, PHILADELPHIA, PENNA.

From the Surgical Pathological Laboratory of the Johns Hopkins Hospital and University

**T**UMORS of this bone are comparatively rare. Very recently Dr. Joseph C. Bloodgood and his staff at the Surgical Pathology Department, Johns Hopkins Hospital, studied some seventeen hundred bone tumors with special reference to anatomical location. Thirty-three, or approximately 2 per cent, involved the cal-

caneum. It is the intention at this time to briefly analyze these tumors with reference to age, incidence, symptomatology, pathology, and treatment, and to include a brief review of the tumors occurring in the literature.

One might expect newgrowths in this area to be rather common if trauma were consid-



Fig. 1. Roentgenogram showing an exostosis of the os calcis. There is a rather large calcified area in the tendo achillis just above its insertion. Two bony growths are present, similar in shape and location to those shown in Figure 2.



Fig. 2. Roentgenogram showing exostoses on the os calcis. Note the beak-shaped spur located at the tendo achillis insertion and a small "rose thorn growth" on the plantar tubercle. The base or pedicle of these small tumors is wide and appears to be a part of the normal bone structure of the os calcis. This is the principal diagnostic feature of exostosis.

ered a very important etiologic factor. The os calcis forms a rather fixed pillar of the longitudinal arch; frequently it is forced to carry the entire weight of the body, as in jumping or falling and landing on the feet.

formed in cartilage, has an ossification center for the body and one for the apophysis and plantar calcaneo-tubercles. The latter two unite with the body about the fifteenth year, paralleling the osteogenesis

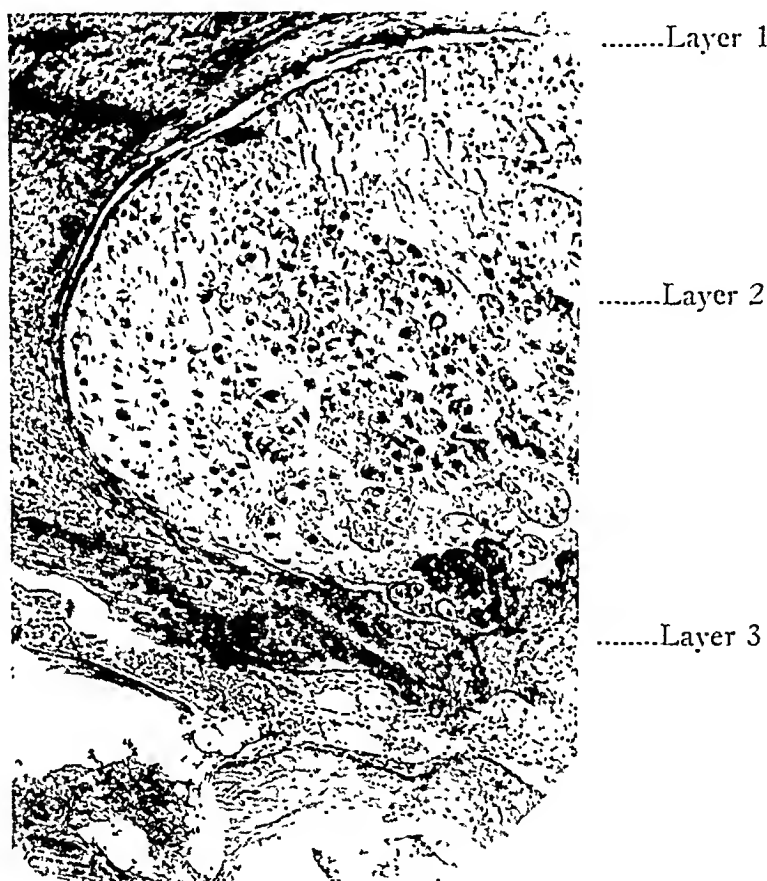


Fig. 3. Photomicrograph showing a typical low-power picture of an exostosis. The first layer (from above downward) is one of primitive connective tissue; a second layer represents normal adult cartilage which is undergoing calcification in its deeper layers; below this is seen normal cancellous bone enclosing islands of fatty bone marrow.

It is constantly exposed to the irritation of ill-fitting shoes. Scudder remarks that it is the most frequently fractured bone in the foot. From the standpoint of anatomy and development and to some extent the behavior and types of the tumors frequently involving it, one's attention is called to its very close resemblance to the long pipe bones, *i.e.*, the femur, tibia, etc. It is pre-

noted in the long bones. It is covered by true periosteum. Two powerful tendons, the Achilles and the tibialis posticus (in part), insert in it; place of origin is also given to the plantar structures.

Ewing's tumor, most commonly found in the long pipe bones, involved the calcaneum twice in this series and four times in cases reported in the literature. Chondromas

occurring in the os calcis progress very much like the chondromas of the long bones and must be watched carefully for malignant changes. Geschickter (1) has emphasized the behavior of this type of tumor in

the calcaneum in 1885; Fahlenbock (5), a giant-cell sarcoma of the os calcis in 1894, while in 1914 W. P. Coues described what was probably the first bone cyst of the os calcis to be reported.

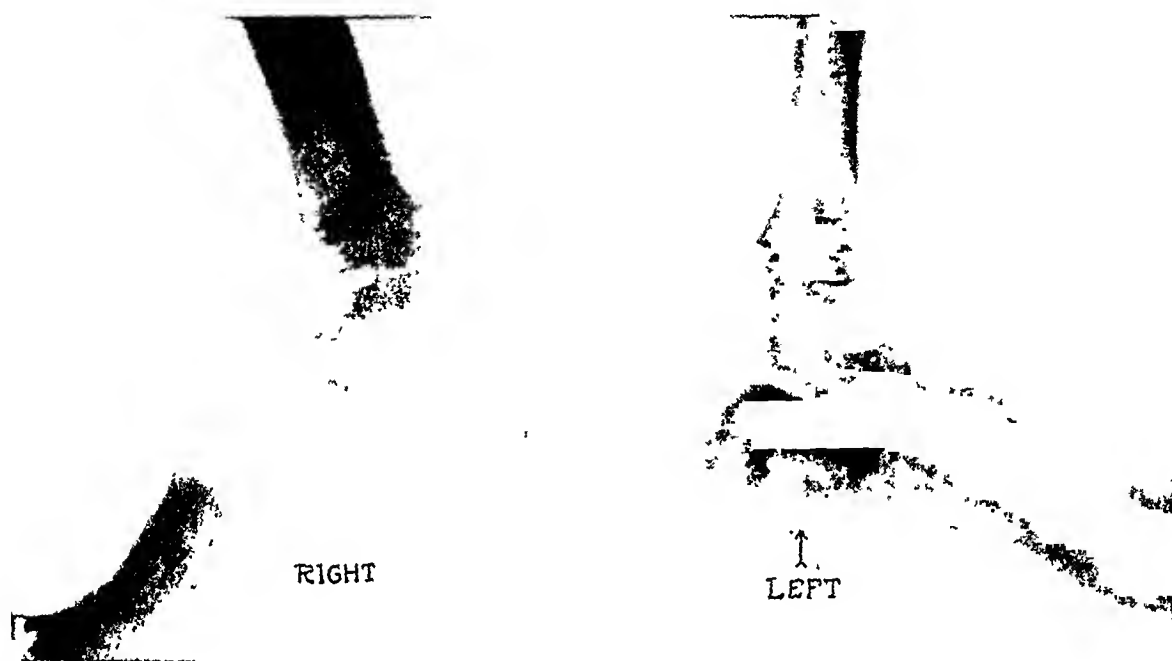


Fig 4-4 Roentgenogram showing chondroma of os calcis. Note the central rarefied area. Bone cell is intact. There are no trabeculations such as are so often seen in the giant-cell tumor and the healing bone cyst.

the os calcis and has stressed its possible malignant tendencies in contrast to the cartilaginous tumors occurring in the metatarsals and phalanges, which are nearly always benign.

Ninety-one tumors of the os calcis were found in the literature for the past fifty-one years. Of this group, 67 were benign exostoses, one chondroma, four bone cysts, four giant-cell tumors, two chondrosarcomas, four Ewing's endothelial myelomas, eight sarcomas (unclassified), and two epitheliomas.

Briggs (2) reported an epithelial growth of the heel involving the os calcis in 1883; S. Bayer (3), a round-cell sarcoma of the os calcis in 1883; Jeannel (4), a chondroma of

Literature on exostoses probably antedates that on all other tumors of the os calcis. W. S. Baer (6), in 1907, and Meisenbach (7), in 1911, were among the first to make a detailed study of these growths.

Table I shows the tumors occurring in the foot. Of 78, the total number, 32 (or 41 per cent) occur in the os calcis. Exostosis is the predominant lesion in the os calcis, phalanges, and metatarsals. The giant-cell tumor is most common in the tarsals. It is interesting to note that metastatic tumors involved the tarsals, metatarsals, and phalanges but never were found in the os calcis. No report of metastases to the os calcis was found in the literature.

## STUDY OF THE VARIOUS TUMOR GROUPS

*Exostoses.*—There were 262 cases of exostoses among the 1,740 bone tumors. Of these, 9 per cent (or 23) occurred in the os calcis. Twenty-one were in males; two were in females. Of the patients, 22 were white and one colored. The average age was from twenty-five to thirty-five years; the oldest case was sixty-five, the youngest ten. Pain preceded discovery of the tumor

from six months to one year. One spur was located near the attachment of the tendo achillis and the remainder appeared on or between the plantar tubercles; as judged from the X-ray films. In this particular series all were treated by excision—three recurred. The microscopic pictures were typical of an exostosis (see Fig. 3). Trauma and infection contributed about equally to the etiology.

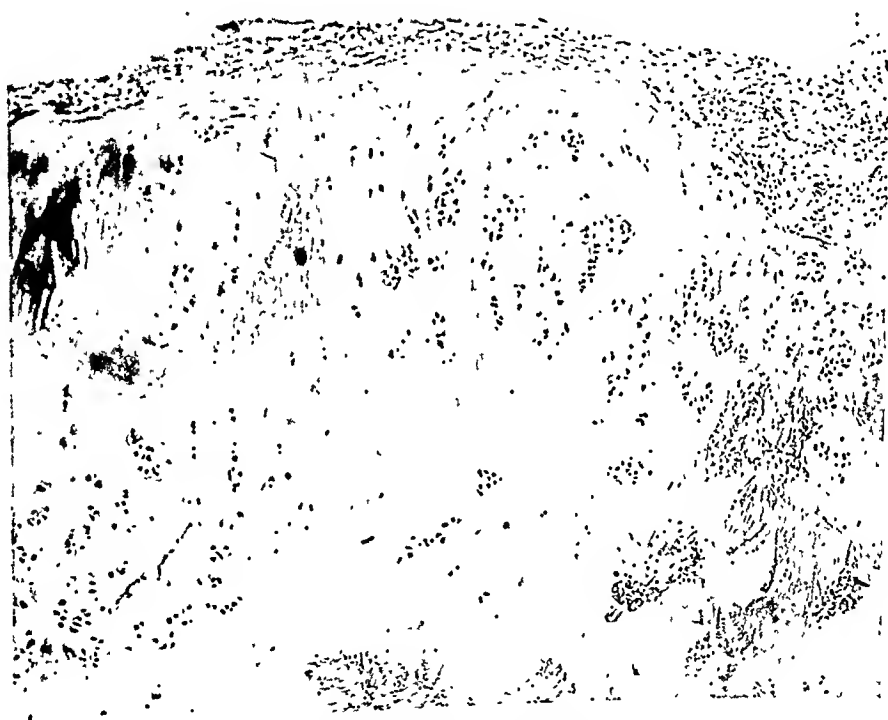


Fig. 4-B. Photomicrograph showing a typical low-power section of a chondroma. The cartilage cells and stroma are of the normal adult type.

TABLE I

ANALYSIS OF THE THIRTY-TWO TUMORS OF THE OS CALCIS STUDIED AT THE JOHNS  
HOPKINS SURGICAL PATHOLOGICAL LABORATORY

|                            | Os Calcis | Tarsus    | Metatarsals | Phalanges |
|----------------------------|-----------|-----------|-------------|-----------|
| Exostosis .....            | 23        | 3         | 3           | 11        |
| Chondroma .....            | 2         | 0         | 0           | 6         |
| Bone cyst .....            | 0         | 1         | 1           | 0         |
| Giant-cell tumor .....     | 2         | 4         | 2           | 1         |
| Chondrosarcoma .....       | 3         | 3         | 1           | 1         |
| Ewing's tumor .....        | 2         | 0         | 1           | 2         |
| Metastatic carcinoma ..... | 0         | 2         | 2           | 2         |
| <i>Total</i>               | <u>32</u> | <u>13</u> | <u>10</u>   | <u>23</u> |





Fig. 5. Central expanding defect in the os calcis. Reproduced by permission from *Jour Bone and Joint Surg.*, April, 1930, XII, 416 )

To quote C. F. Geschickter:<sup>1</sup>  
 "Histogenically these tumors are considered to be an exaggeration of a normal bony

<sup>1</sup>C. F. Geschickter. Bone Tumors of the Fibrocartilaginous Group. To be published in *Archives of Surgery*.



Fig. 6-B. Roentgenogram of left os calcis taken for comparison with Figure 6-A (same case).

protuberance intended for the anchoring of an important tendon. At such a junction



Fig. 6-A. Roentgenogram of right os calcis taken ten days after trauma. There are two very small areas of rarefaction near the center of the calcaneum.



Fig. 6-C. Typical roentgenogram of a giant-cell tumor. Right os calcis ten months after injury. There is an expanding central tumor, with marked bone destruction. Trabeculation is present. Same case as shown in Figures 6-A and 6-B.

Nature provides normally for a protuberance of bone bulging through a gap in the periosteum to meet an adjoining tendon, which co-operates in the formation of the attachment by cartilaginous ossification within the substance of the tendon. An exostosis represents a failure in the accurate approximation of the tissues entering into such a junction, the cartilaginous center in the tendon persisting in the form of primitive connective tissue, proliferating in excess, and the protuberance of normal bone beneath extending to form a pedicle or base."

Spurs are most commonly found on the plantar tubercles, secondarily at the insertion of the tendo achillis, and third in order of frequency at the insertion of a slip of the tibialis posticus. Figures 1 and 2 represent the first-mentioned locality, while Figure 3 shows a low-power microscopic view of an exostosis. With one exception, all the exostoses in this series appeared as rather small spur-like processes, which appears to be rather typical of the cases reported in the literature with so-called infectious origin. However, there exists probably another type, not represented in this series, which has an appearance more similar to the congenital exostosis frequently seen in the long bones. Kurtz, of Philadelphia, and Levin, of Chicago, both have reported tumors probably of this type. In several cases of multiple exostoses reviewed, none involved the os calcis. Whitmore and Smith, writing in the *U. S. Naval Medical Bulletin*, reported a case with multiple exostoses, seventy-two in number, but the os calcis was not involved.

**Chondromas.**—There were two classes of chondroma involving the os calcis, in white males, aged nineteen and twenty-five years, respectively. Pain and tumor were the principal symptoms. Following curettage, one remained well for four years; the second had recurrences and amputation was ad-



Fig. 6-D. Roentgenogram of right os calcis taken sixteen months after injury, showing that the tumor has doubled in size. The bone shell has been perforated and soft parts are invaded. Same case as shown in Figures 6-A, 6-B, and 6-C.

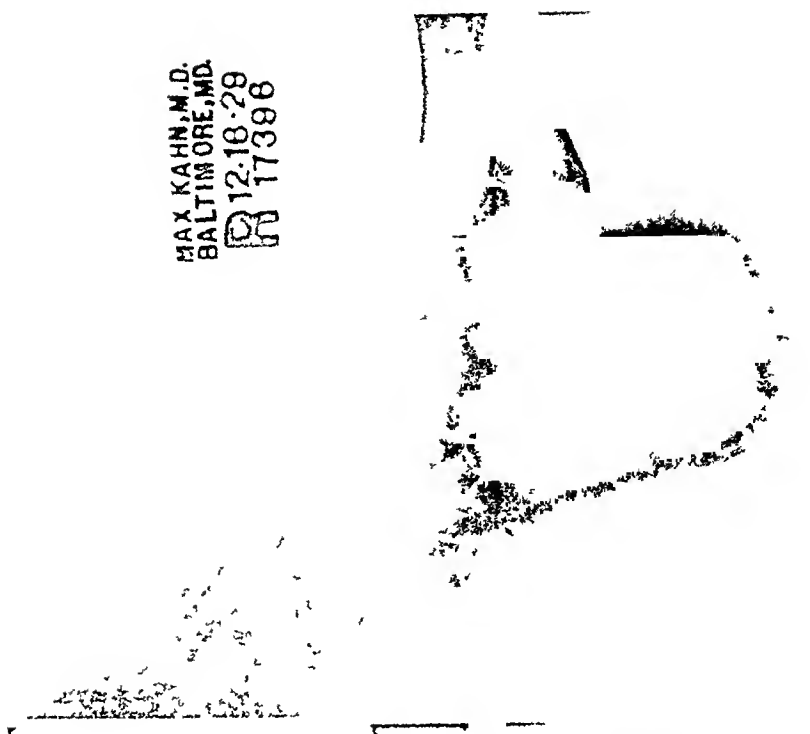
vised. Figure 4-A represents a chondroma of the os calcis and Figure 4-B is a typical microscopic picture.

**Bone cysts.**—No bone cysts were found in this series. Figure 5 is a reproduction of a reported case.<sup>2</sup>

**Giant-cell tumor.**—Three cases (two males, one female) occurred in this series. The age averages from thirty to forty years in this group of tumors. Symptoms of intermittent pain, swelling, and tumor are common, their average duration being fifteen months. Two cases were treated by curettage and the patients are well after five years; in one, resection was performed and the patient is well, four months after resec-

<sup>2</sup>Used by permission; N. R. Smith, *Cyst of Os Calcis*. *Jour. Bone and Joint Surg.*, April, 1930, XII, 416.

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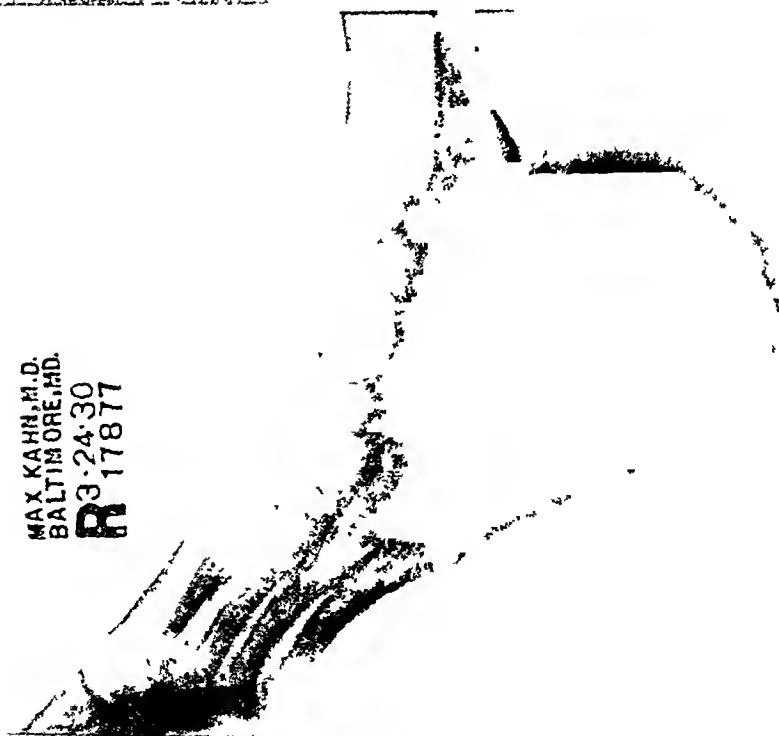


Fig 6-E (above) Roentgenogram showing the os calcis eighteen months after the injury. Patient had just completed two months of intensive deep X-ray therapy. The growth was not checked and the entire posterior two-thirds of the calcaneum is now destroyed. Some trabeculation is present along the plantar surface and probably represents a reaction to the X-ray therapy. Same case as shown in Figures 6-A, 6-B, 6-C, and 6-D.

Fig 6-F (below) Roentgenogram of same case taken nineteen months after the injury, showing almost complete replacement of the os calcis by tumor.



Fig. 6-G Photograph showing a sagittal section through the gross specimen. Note the grumous nature of the tumor, the areas of hemorrhage and cystic degeneration

tion. Figures 6-A to 6-I, inclusive, show the case treated by resection of the os calcis. This series of X-ray films is quite unusual in that it represents probably the complete his-

tory of a tumor from origin with trauma, rapid growth period, almost complete destruction of the os calcis, refractoriness to X-ray therapy, and cure by excision of the os

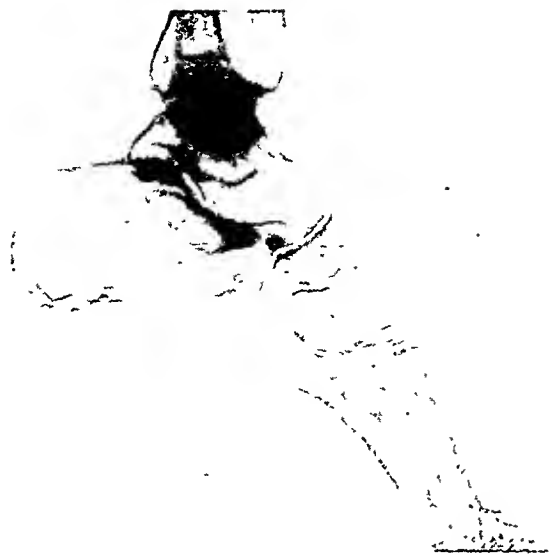


Fig. 7. Roentgenogram showing a rather typical slow-growing giant-cell tumor of the os calcis. There are areas of destruction without any evidence of bone production. Trabeculation is quite marked. The bone shell is intact.

calcis. Note that the first X-ray film was taken ten days after the patient had received a rather minor injury to the right os calcis. There was a perfectly negative history prior to this time. Figure 6-E shows the tumor after twelve deep X-ray treatments: the growth was not checked. Figure 7 is a giant-cell tumor of the os calcis of very slow growth. Note the trabeculation and intact bone shell. This case was cured by curettage.

*Chondrosarcoma of the os calcis.*—There were three cases (ages 31, 43, and 56 years, respectively), all in white males and all secondary to a preceding chondroma. The symptoms included pain and tumor and the treatment was amputation. The results showed: one patient well for five years, one living for three years, with recurrence, and one dead. All of these cases represent malignant changes in a chondroma. The sections, typical of chondrosarcoma, show fetal cartilage and myxomatous tissue. Figure 8-A shows a gross specimen of the

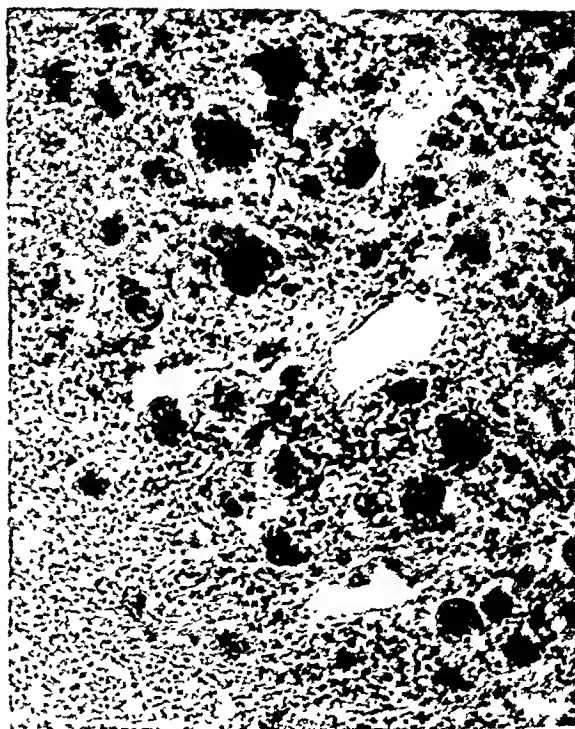


Fig. 8. Photomicrograph of low-power section of the giant-cell tumor. Note the numerous giant cells that predominate in a stroma of small round cells.

os calcis. Figure 8-B is a roentgenogram of the same specimen, and Figure 8-C is the high-power photomicrograph.

*Ewing's tumor.*—There were two cases in this group. Case 1, aged 14, was a white female, with pain and tumor of the os calcis of twenty-four months' duration. The X-ray examination showed a marked sclerosis of the os calcis, at first diagnosed as chronic non-suppurative osteomyelitis. The lesion was incised and drained, followed later by amputation, and finally resulting in death. Figures 9-A and 9-B show this case of very marked sclerosis of the os calcis. Figure 9-C is the photomicrograph. Case 2 was a white male, aged 39 years, with pain and tumor of twenty-four months' duration. The X-ray film showed marked destruction of bone. The diagnosis was made by biopsy. Amputation was followed by death in five months. The



Figs 9-A and 9-B Chondrosarcoma of os calcis. A photograph of the foot and the gross specimen removed by amputation. The section is sagittal. Observe the cartilaginous tumor surrounding the os calcis. The calcaneum has been destroyed for the most part. Lobulation of the cartilage mass can be easily seen.

#### SUMMARY

Of 1,740 tumors reviewed at Johns Hop-

microscopic sections showed a typical Ewing's sarcoma.

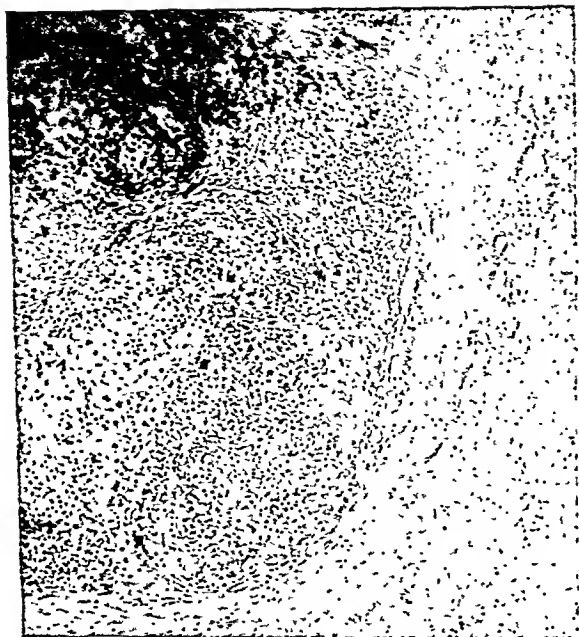


Fig. 9-C. Photomicrograph showing typical high-power section of chondrosarcoma. Note the fetal cartilage cells and myxomatous areas lying in a stroma of embryonic connective tissue (See Case 2, under "Ewing's tumor").

kins Surgical Pathological Laboratory. 33 (or 2 per cent) involved the os calcis. Exostosis was the most common newgrowth, occurring in 23 of the total number. All were treated by excision; twenty were cured, three recurred. No malignant changes appeared in this series. Dr. Geschickter has informed me that he has one exostosis of the os calcis in which a chondrosarcoma (?) developed. Chondroma, giant-cell tumor, chondrosarcoma, and Ewing's tumor compose the remainder. No bone cysts, myeloma, or metastatic tumors were found. Chondromas of the os calcis must be treated as chondromas of the long bones. They should be watched carefully, with frequent X-ray examination, and the malignant possibilities constantly borne in mind. If malignant changes are in evidence, they must be treated as chondrosarcoma. Early amputation offers the only hope. The giant-cell tumors, if recognized before the shell is perforated, respond to curettage and apparently have little tendency to recur. Ex-

cision or amputation may be necessary when soft-part invasion is extensive. Ewing's tumor offers little hope for life, if one may judge by the two cases reported. However, in both cases diagnosis was not made for twenty-four months. It is possible that with early diagnosis amputation and X-ray therapy might have helped.

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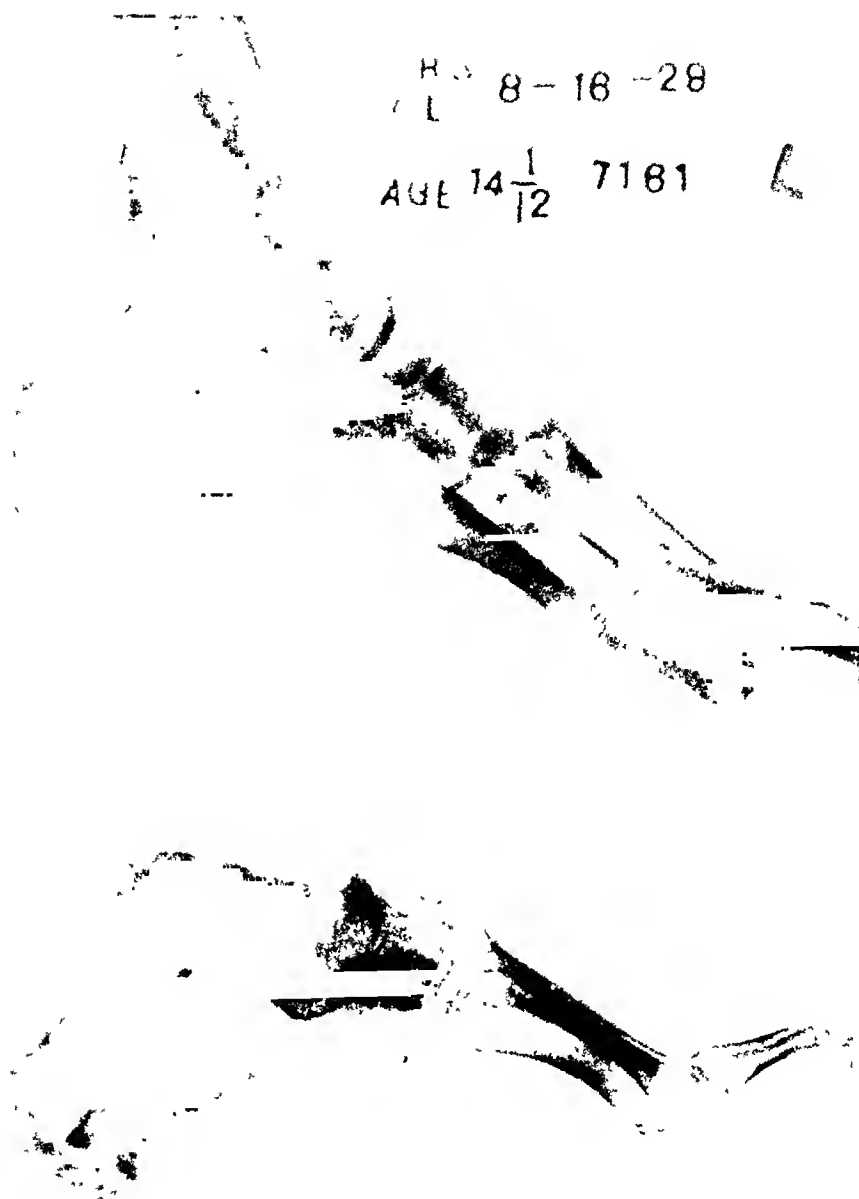


Fig. 10-A (*above*) Ewing's endothelial myeloma of os calcis, showing rather characteristic osteosclerosis that predominates in certain stages of Ewing's tumor and is often mistaken for non-suppurative osteomyelitis. There are occasional small areas of bone destruction. On the plantar surface there is some new periosteal bone production laid down parallel to the long axis of the os calcis.

Fig. 10-B (*below*). Roentgenogram of same case shown in Figure 10-A, three months later. Bone destruction is now becoming more noticeable. Osteosclerosis is not quite so pronounced. The foot at this time has just been removed by a disarticulation at the ankle joint.



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Fig. 10-C. Photograph showing sagittal section of the gross specimen. (Same case as shown in Figures 10-A and 10-B.) Note the strikingly increased density in the anterior two-thirds of the os calcis and the areas of destruction and hemorrhage in the posterior third.

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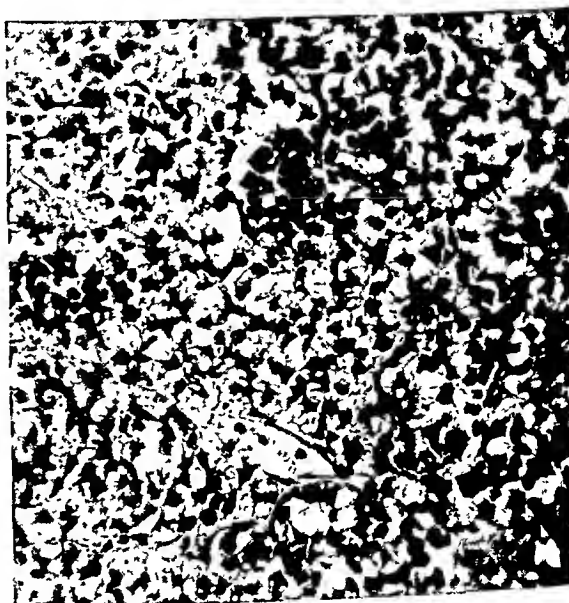


Fig. 10-D. Photomicrograph showing a typical high-power section of Ewing's tumor. Note that small round cells predominate and very little exists.

# BONE LESIONS OF THE LOWER RADIUS

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From the Surgical Pathological Laboratory of the Johns Hopkins University

THE radius, the lateral and shorter bone of the forearm whose rotation pronates and supinates the hand, and the pathological variations of its lower end, are considered in this report. This bone is easily palpable in its entire course, though deep pressure is necessary in its mid-portion. Deformity and loss of function of this part are of inestimable importance and it is for this reason that the present study is being made, in the hope that diagnosis of the lesion may be the more accurately arrived at and the correct treatment advised for the preservation of function of the arm and hand.

In the accompanying table, the relative frequency of the different types of bone lesions found in the lower end of the radius is compared to the total number of lesions of each different type. In over two thousand bone lesions there were but 56 cases in which the lesion was found in the radius, and of these, 50 were in the lower end, representing about 90 per cent of the cases. The following is the order of frequency of involvement in the long bones—femur, tibia, humerus, radius, fibula, and ulna.

In this whole group, then, there were 45 central lesions and 5 periosteal lesions as portrayed by the X-ray. There were only 4 malignant lesions. The percentage of cures in the giant-cell tumor may seem



Fig. 1. Forearm of a young patient with hereditary deforming chondrodysplasia. There are multiple exostoses, the most pronounced of which is in the lower end of the radius.

TABLE I

| Type                                      | Total number cases | Radius  |            | Percentage | Cured (percentage) |
|---|--------------------|---------|------------|------------|--------------------|
|   |                    | Central | Periosteal |            |                    |
| Non-suppurative osteomyelitis.....        | 106                | 3       | --         | 6          | 100                |
| Exostosis (Multiple 10, in radius 2)..... | 262                | --      | 4          | 8          | 100                |
| Chondroma .....                           | 71                 | 1       | --         | 2          | 100                |
| Bone cyst .....                           | 151                | 3       | --         | 6          | 100                |
| Giant-cell tumor.....                     | 226                | 35      | --         | 70         | 74                 |
| Chondroblastic sarcoma.....               | 21                 | 1       | --         | 2          | 0                  |
| Ewing's tumor .....                       | 70                 | 1       | --         | 2          | 0                  |
| Osteolytic sarcoma .....                  | 93                 | 1       | --         | 2          | 0                  |
| Sclerosing sarcoma.....                   | 63                 | --      | 1          | 2          | 0                  |



Fig. 2-A. Roentgenologic study in a case of recurrent giant-cell tumor in the lower end of the radius, showing the lesion before operation. Note the advanced bone destruction and the perforation of the bone shell.



Fig. 2-B. Same case, showing recurrence after the first curettage. Note the absence of ossification.

small, but this will be discussed under the individual types. The various groups as outlined above must now be considered individually.

#### NON-SUPPURATING OSTEOMYELITIS

The frequency of non-suppurating osteomyelitis in the radius is relatively small. The X-ray appearance, according to Cohn, varies from osteoporosis to sclerosis, with all intervening grades and the admixture frequently of both osteoporosis and sclerosis. In his series of cases there were questionable diagnoses between this condition and sarcoma in 33 per cent of the cases. The age incidence is the same as that of sarcoma. The duration of the disease formerly aided in the diagnosis, but now cases are coming under observation earlier and this increases the difficulty in diagnosis. The X-ray film may show evidences of bone formation similar to the spurs seen in a simple exostosis and more advanced states, when the shaft

is almost completely surrounded by new bone formation, and finally may make itself conspicuous by its presence as a subperiosteal growth. Wherever there is bone destruction along with the sclerotic process there is increased difficulty in diagnosis. As to treatment, again we quote Cohn: "When the X-ray suggests sarcoma, and the tumor is resistant to irradiation, and where the foci of infection are ruled out, an exploratory operation is justifiable provided the tumor, if malignant, is operable."

In the study of the cases occurring in the radius, three patients with non-suppurative osteomyelitis were found, aged, respectively, fourteen, seventeen, and twenty-three—well within the usual age limits. All of these cases had two or more bones involved. The duration of the condition in the three cases varied from eighteen months to seven years. The extremely chronic case was syphilitic and improved after anti-syphilitic treatment. The second patient of this group had had a typhoid infection four years pre-

viously, was not operated upon, and remains unimproved after a number of years. The last case gave a history of eighteen months' duration. At operation, the microscopic examination revealed nothing but granulation tissue. This patient has been well for a period of seven years.

The percentage of cures in this general group of non-suppurative osteomyelitis is about 90 per cent. Two cases out of the group were recurrent, ten were progressive, and three proved malignant in the years following. None of these unsuccessful cases, however, occurred in the lower radius.

### EXOSTOSIS

Exostoses are found usually near the ends of the long bones; in the radius, however, they are comparatively infrequent. This condition occurs usually between the ages of ten and twenty-five and consists of a bony spur covered by adult cartilage. Patients are frequently asymptomatic, but the growth may make itself conspicuous by a painless swelling near a joint or by a stiffening of the joint. The X-ray film reveals an outgrowth of cancellous and compact bone merging imperceptibly with the normal bone of the shaft. The microscopic findings are normal adult bone and cartilage.

There were, in all, 262 cases of exostoses, of which 70 per cent occurred in the long bones of the extremities. Seven cases were in the radius, with four in its lower end. Twenty-two out of the entire number were multiple. Two of the four cases in the lower radius were multiple—one patient, a girl of ten, came from a family in which there was a history of three similar cases. All of the cases presented pedicle exostoses in the X-ray examination. In two cases no operation was done, in one a biopsy, and in the other an excision. All the patients have remained in good health for from four to ten years. One must conclude from this that with careful observation of the progress of



Fig. 2-C. Same case, showing recurrence after the second curettage. There has been re-ossification and healing, except at the styloid process of the radius.

the exostosis, with occasional X-ray examination in cases in which deformity is not too marked and the function is undisturbed, no treatment is necessary unless there is undue increase in the size of the tumor and its presenting symptoms. If necessary, the operation of choice is simple excision. Only 5 per cent of this general group shows later malignant change. It is interesting to note here that when multiple exostoses do occur, the fibula or radius is affected.

### CHONDROMA

Benign chondromas are usually central and occur chiefly in the small bones of the

hands and feet. The symptoms are mild and consist usually of a swelling, slowly increasing in size, with occasional soreness. The picture seen on the X-ray film is a central area of rarefaction surrounded by an

these in the radius. This was a case in which there was chiefly a hypertrophy of the joint cartilage. This small tumor was removed by simple excision and the patient is now well, with no recurrence.



Fig 2-D Same case, showing transplant after resection. Function has been restored, but there is marked ulnar deviation of the hand

expanded shell of cortical bone. Removal of the tumor by excision or curettement, with chemical or thermal cauterization, is sufficient, but incomplete removal tends towards recurrence, which may or may not assume malignant characteristics. The histologic picture is that of adult cartilage interspersed with strands of connective tissue. Frequently this type of tumor is not pure in form but is mingled with myxoma. The prognosis is good

The cases in this group number 71. Chondromas of the long bones are rare. Of the series, only six cases were found in the long bones of the extremities and only one of

#### BONE CYSTS

Bone cysts are stated to be frequent in children under fifteen or eighteen years of age. Latent bone cysts may appear in later adult life. The clinical course of the disease is mild, being disturbed at times by pathologic fracture, which is one of the frequent reasons for bringing the patient under a physician's observation. The lesion occurs in the metaphysis of a long bone, especially in the femur, in which there were 50 cases, and the humerus, with 45 lesions. Bone cysts are rare in the radius, there being only four cases as compared with the above. The

X-ray film reveals a lesion central in the shaft of a long bone, with marked decrease in density. There is a symmetrical contour and a smooth, well-defined outline. Lines of trabeculation may be seen traversing the

six, who had had a tumor for ten years and whose X-ray film showed cystic expansion of bone, had few or no symptoms. The last was a woman of forty-five, who, two years previously, had had a tumor and

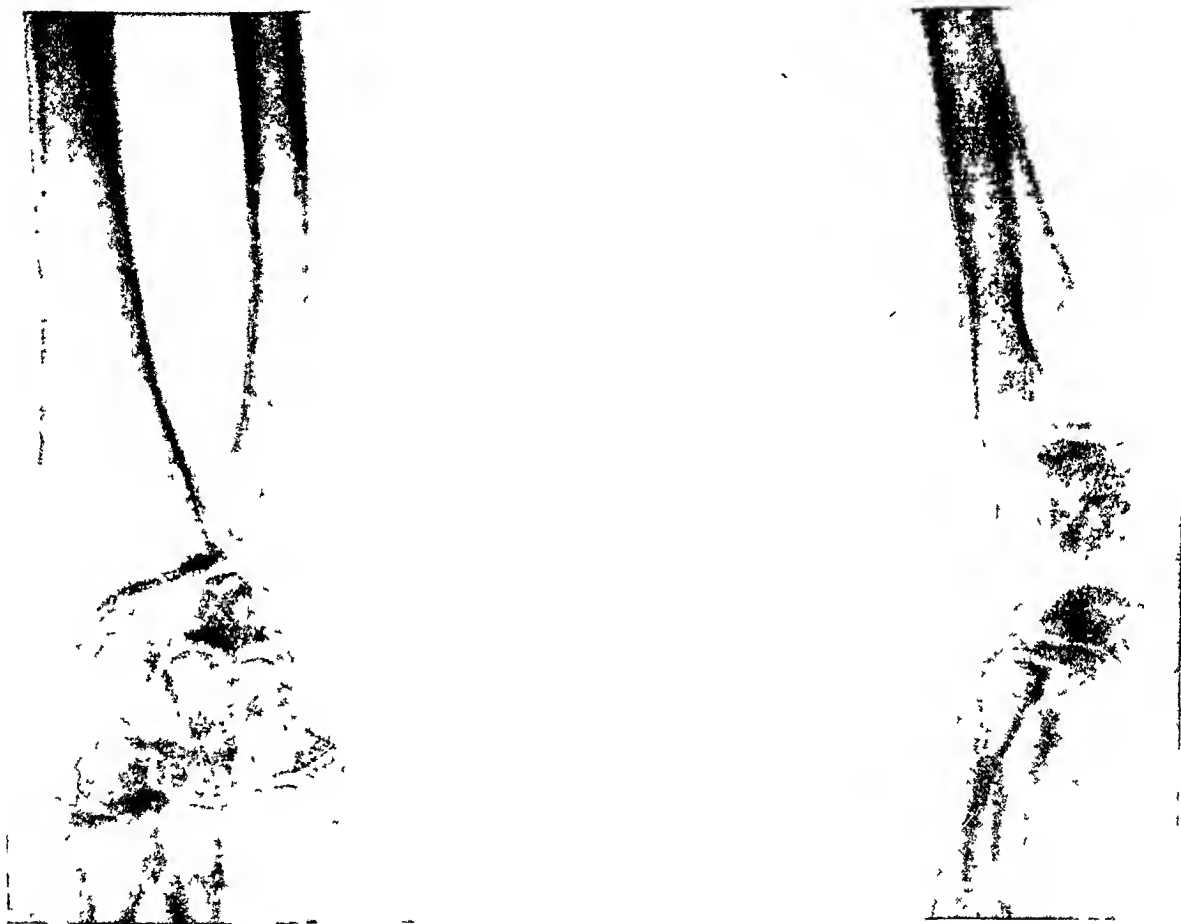


Fig 3 An early osteolytic sarcoma at the epiphyseal line of the radius

area of lesser density. Where there has been a pathologic fracture there is a tendency towards ossification. In adults, latent bone cysts are found, but there is much less danger of pathologic fracture. Microscopically, the sections show a fibrous tissue wall with or without giant cells.

In the lower end of the radius there were three cases—one, a girl aged twelve, whose X-ray film showed central expansion of bone, with fracture. Another, aged twen-

ty-six, who had had a tumor for ten years and whose X-ray film showed cystic expansion of bone, had few or no symptoms. The last was a woman of forty-five, who, two years previously, had had a tumor and

were good, with 100 per cent cures. The treatment of bone cysts is simply the removal of the connective tissue lining and

progressive lesion and frequently perforates its capsule. If this occurs, the chances of a cure are diminished because of the dif-



Fig. 4. A sclerosing osteogenic sarcoma in the metaphysis of the lower radius. Marked sclerosis and radiating spicules of new bone are present.

the obliteration of the cavity with bone chips.

#### GIANT-CELL TUMOR

In adults, usually above the age of twenty, occurring in the epiphyses of the long bones, there is a group of cases which makes up the greater number of the lesions in the lower end of the radius. In the X-ray examination they show central expansion of the cortical bone similar to that of the bone cysts, though in these lesions the contour is asymmetrical. These cases, too, are frequently brought to the physician's attention because of pathologic fracture. This is a

difficulty of complete removal. The microscopic picture varies, resembling in some cases that of a bone cyst, with the exception that the giant cells are more prevalent usually and the stroma is made up of small round cells rather than the spindle cells which sometimes predominate in the picture of the bone cyst. The treatment of this type of lesion consists of curettement along with thermal or chemical cauterization.

The lower radius ranks first as the most common position for the giant-cell tumor, followed closely by the lower femur and the upper tibia. Out of a total of 226 cases, 35 were in the lower radius—over 15 per

cent of the total number of cases. Of the tumors of the lower radius, the giant-cell tumors made up 70 per cent. Nine of the 35 cases recurred following curettement. Thirty cases were well following treatment, including those with two or more curettages. In four instances follow-up results could not be obtained. Many of these patients have been well for as long as twenty years and have useful function of the arm and hand. In this group, then, 26 per cent of the cases were recurrent after the first operation. The percentage of cures in this entire group of giant-cell tumors is 85 per cent. Recurrences are met with in about 15 per cent of the cases.

#### SARCOMA

(a) *Osteogenic osteolytic sarcoma*.—In this type of tumor the position is at the epiphyseal line. The X-ray film shows a mottled area of bone destruction, central in appearance, with or without bone expansion. Microscopically, at the margin there are found giant cells, as in the malignant giant-cell tumor, but in reality it is a form of osteogenic sarcoma with giant cells—a destructive type. In our group there was only one case of this tumor, and death occurred the same year, following amputation, which had been preceded by X-ray treatment.

(b) *Ewing's tumor*.—Ewing's tumor rarely involves the epiphysis unless it is secondary. The clinical picture may aid in the diagnosis here, as fever and leukocytosis usually occur in the complex of symptoms. The X-ray film shows a widened shaft of bone. The laying down of parallel layers of bone in the so-called "onion-peel" fashion is typical. Microscopically, this tumor is composed of small round cells, with a dense nuclear staining and little cytoplasm. Post-operative X-ray treatment following amputation resulted in death one year later in the only case in this group. The percentage of cures in this general group is approximately 10 per cent.

(c) *Chondromyxosarcoma*.—Only one case of this type was found in the radius. Because of the fuzzy, infiltrating shadow in the central position in the X-ray film, the lesion was regarded as secondary to a pre-existing chondroma or chondromyxoma. The usual age limits of the secondary tumor are from thirty to fifty years. The histological picture is that of a spindle-cell sarcoma mingled with premature cartilage cells and the typical stellate cells of a myxoma. Exploration was done in this case and was followed by curettage. X-ray treatment and toxins were given post-operatively. This patient died shortly after the operation.

(d) *Sclerosing sarcoma*.—Sclerosing sarcoma occurred once in the lower radius. X-ray examination in this type of tumor shows dense radiating new bone in the metaphyses of the long bones, proliferating from the subperiosteal region, raising the periosteum and extending inward toward the marrow cavity. Microscopically, the tumor shows many osteoblasts and much osteoid tissue. The treatment here, as in the other sarcomas, is excision, resection, or amputation, preceded and followed by X-ray treatment. There is very little evidence that the sclerosing tumor is radiosensitive. The value of X-ray therapy is doubtful. Excision and resection in the above case was followed by death in seven months. Thirty-one per cent of the cases of this general group were five-year cures following amputation.

#### DIFFERENTIAL DIAGNOSIS

Differentiation must first be made between the central and periosteal groups. In Table I the periosteal lesions are exostosis and sclerosing sarcoma. At times also non-suppurating osteomyelitis presents itself as a periosteal lesion. There is little difficulty in the diagnosis of the benign exostosis. The X-ray appearance is distinctive and typical, showing a uniform protuberance of normal bone. The difficulty arises in the differentia-



tion between osteomyelitis and sclerosing sarcoma. In osteomyelitis, there is both osteoporosis and osteogenesis, without the radiating new bone seen in sarcoma. A history of long duration of the disease and the multiplicity of lesions should lead to the diagnosis of osteomyelitis. When there is difficulty, irradiation may be tried—response to this may make the diagnosis. When there is no response to X-ray treatment and no focus of infection can be found, exploration is done, provided the tumor is operable—if malignant. Frozen sections will make the diagnosis.

Chondromas, bone cysts, and giant-cell tumors present central areas of rarefaction. Contour, position of the tumor, and age incidence enable one to distinguish between bone cysts and giant-cell tumors. Chondroma of the long bones is rare and at times cannot be differentiated. The operative procedure is the same for all central tumors—complete removal and cauterization.

The sarcomas may be differentiated by the irregular outlines seen on the X-ray film. The position of the tumor may aid. In the osteolytic type, which shows a mottled, fuzzy picture, the tumor is found at the epiphyseal line. Chondromyxosarcoma may present a similar picture, but there is more

irregular bone destruction in the osteolytic sarcoma. Ewing's tumor is found in the shaft unless it is secondary. A clinical history of fever and leukocytosis, with the laying down of bone in "onion-peel" fashion, is characteristic. Sclerosing sarcoma has been considered in the differentiation of periosteal lesions.

#### SUMMARY

Fifty lesions of the lower radius have been studied. Nine different types of lesions were found.

The giant-cell tumor predominated, occurring in 70 per cent of the lesions.

Cases are discussed under each group and the results given.

Excellent results were obtained in all of the benign lesions.

Results in the giant-cell tumor group were low on account of the advanced state of the disease. Seventy-four per cent of these cases were cured after the first treatment.

All cases of non-suppurating osteomyelitis, exostosis, chondroma, and bone cysts are well following observation and treatment.

All cases of sarcoma resulted in death. The differential diagnosis is discussed.

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# TUMORS OF THE SMALL INTESTINE

THEIR DIAGNOSIS, WITH SPECIAL REFERENCE TO THE X-RAY APPEARANCE

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## I.—INTRODUCTION

TUMORS of the small bowel are conceded by pathologists and surgeons to be of extremely rare occurrence. So infrequent are they, in fact, that the occurrence of two cases on the wards of the Johns Hopkins Hospital during the past year has prompted a survey and study of all tumors occurring in this location in the history of the clinic. This paper deals with the clinical aspects of such tumors, with special reference to the roentgenologic findings. A complete *résumé* of the subject, with a detailed report of all tumors found, is to be published later.

The records of this hospital yielded 82 cases of primary tumors located between the pylorus and the ileocecal junction. This comprised 6.5 per cent of all tumors of the gastro-intestinal tract, agreeing roughly with statistics of other writers on the subject. Of this number, 32 (or 40 per cent) were malignant and 50 (or 60 per cent) were benign; 37 per cent gave definite symptoms and were operated upon; 17 per cent gave symptoms but were not operated upon, and the condition was recognized at necropsy; 46 per cent were asymptomatic and were found secondarily at autopsy. The types of tumors found and their locations are shown in the accompanying table.

Only a small percentage of the symptomatic group were diagnosed before operation, the majority being confused with some other intra-abdominal condition. The clinical symptoms and physical findings were most bizarre and very few conformed to a standard picture. Diagnosis, therefore, from the clinical findings alone is at

best a hazardous guess. Of the 42 symptomatic cases, the mechanical condition brought about by the tumor was recognized in 14. In six of these the tumor was diagnosed as the cause of symptoms; in eight of the 14, the roentgenogram was responsible for the diagnosis.

X-ray findings are by no means as helpful in lesions of the small intestine as in other parts of the gastro-intestinal tract. There are, however, some cases in which the X-ray plates following an opaque meal are of extreme value, and clinicians are realizing more and more the value of a thorough X-ray examination in obscure cases of gastro-intestinal disorders. Recent publications by Golden (1), Soper (2), and Ritvo (3) have done much to clarify the evaluation of this means of examination. One cannot be justified in considering the X-ray findings as infallible. Negative findings do not exclude a lesion. Positive findings, confirmed by repetition, while revealing the mechanical nature of the disturbance, seldom allow the diagnosis of the nature of the tumor. Careful and intelligent correlation of clinical findings with the X-ray examination may, however, aid materially in establishing the diagnosis before operation.

The technic of X-ray examination of the small bowel must be considered in detail. A flat plate of the abdomen is essential for comparison with the other plates of the series, as well as to reveal the presence of large, dense, intra-abdominal masses. The barium meal is administered following the flat plate. All plates should be taken with the patient standing. The time for the first plate may well be placed at one-half hour following the ingestion of the barium. *Th*

TABLE I.—CLASSIFICATION AND LOCATION OF TUMORS OF THE SMALL INTESTINE

|           | Type                        | Location<br>undetermined | Duodenum | Jejunum | Ileum | Totals |
|-----------|-----------------------------|--------------------------|----------|---------|-------|--------|
| Malignant | Carcinomas                  | 2                        | 7        | 5       | 6     | 20     |
|           | Sarcomas                    | 1                        | 1        | 2       | 10    | 14     |
| Benign    | Chronic inflammatory tumors | 1                        | 0        | 0       | 5     | 6      |
|           | Adenomas                    | 2                        | 6        | 1       | 10    | 19     |
|           | Fibromas                    | 0                        | 0        | 2       | 2     | 4      |
|           | Lipomas                     | 0                        | 2        | 1       | 3     | 6      |
|           | Myomas                      | 0                        | 0        | 2       | 1     | 3      |
|           | Hemangiomas                 | 0                        | 0        | 1       | 1     | 2      |
|           | Pancreatic rests            | 0                        | 1        | 0       | 1     | 2      |
|           | Hematomas                   | 1                        | 0        | 0       | 1     | 2      |
|           | Argentaffine tumors         | 0                        | 0        | 0       | 3     | 3      |
|           | Cysts                       | 0                        | 1        | 0       | 0     | 1      |
|           | Total                       | 7                        | 18       | 14      | 43    | 82     |

allows the opaque material time to reach and fill the duodenum, which should show best at this time. The following plates should be made at intervals to suit the time of passage of the barium through the intestinal tract: four and eight hours are the intervals of choice, followed by a 24-hour plate on the succeeding day. A barium enema should be given last. This is essential, to rule out involvement of the large intestine and to depict certain tumors near the ileocecal junction which press upon the cecum and cause a filling defect.

The films are developed and read as usual. If there is a lesion visible in one plate of the series, but in one plate only, the series should be repeated for confirmation. Slightly over-exposed plates show filling defects more clearly, and for this reason should be used in the majority of cases.

## II.—PATHOLOGY

A brief consideration of the pathology of this group of tumors is pertinent here, especially in reference to their gross characteristics.

Carcinomas lead in frequency of occurrence, closely followed by adenomas and sarcomas, in the order named. Lipomas, tumors of the chronic inflammatory group, fibromas, myomas, and tumors of the carcinoid type follow in order of frequency. Those of a rarer type include hemangiomas, hematomas, pancreatic rests, cysts, and endotheliomas.

GROSS.—The tumors may be roughly divided into two groups based on their gross pathology: those forming constricting annular growths, and those originating on one side of the wall of the intestine and remain-

ing fairly well localized at the point of origin.

(A) *Annular tumors*.—Most of this group is comprised of malignant growths, carcinomas predominating. Sarcomas also tend to produce a circular growth, but their tendency is more toward an expansive growth involving the mesenteric glands and extending lengthwise along the intestinal wall. The so-called "garden hose intestine" of MacCallum is produced by sarcomatous infiltration of the lower ileum. There were no examples of this form in this group of tumors. Certain benign tumors, namely, those classified as chronic inflammatory by Liu (4), sometimes produce a constricting growth, although the differentiation between these and certain lymphosarcomas is still a moot point. This may possibly be helpful in differential diagnosis, but too few cases have been seen as yet to allow one to judge its diagnostic significance.

(B) *Asymmetric tumors*.—The majority of tumors of the small intestine fall under this morphologic classification, but this term includes those tumors which arise from the wall and grow either inwardly or outwardly without encircling the gut. A further subdivision into internal and external may be made, based on whether the tumors grow toward or away from the lumen of the gut.

(1) *Internal*.—The benign tumors such as myomas, fibromas, lipomas, etc., usually grow in the direction of the lumen, probably for the reason that the mucosa and submucosa offer less resistance to growth than the muscularis and serosa. These tumors vary in size from that of a pinhead to that of a hen's egg (seldom larger than the latter) before symptoms of obstruction indicate surgical intervention. Tumors growing internally may be pedunculated or sessile. The former group is comprised almost entirely of adenomas and lipomas, which are usually papillary outgrowths attached to the inner wall by a pedicle varying in size from

a slender stalk to a thick cord a centimeter or more in diameter and in length from a few millimeters to three or four centimeters. Sessile tumors are attached to the wall by a broad flat base and are covered loosely by intact mucous membrane unless eroded by pressure necrosis.

(2) *External*.—This type of tumor is less frequently found than the internal type; as a rule, this type is malignant rather than benign. The tumor grows outward by extension, either free, into the peritoneal cavity, or along the mesentery, involving the mesenteric glands. These are the tumors which attain the largest size, some becoming as large as a child's head before general malaise urges the rapidly declining patient to seek medical relief for the easily perceptible mass in the abdomen. Examination of the specimen may show it to lie loosely in the abdominal cavity attached to the intestine at a single point, or, as in the case of more malignant tumors, surrounding viscera may be caught and involved in the extensive growth.

**MICROSCOPIC.**—The histological picture of these tumors is very similar to the same types of tumors elsewhere in the body, and as a rule they are easily recognized. Malignant epithelial tumors usually arise from the epithelium of the intestinal glands and are classified as adenocarcinomas. Sarcomas occur quite frequently, practically always in the lower part of the ileum, and are usually of lymphocytic origin. They resemble closely the tumors of the chronic inflammatory group and in the majority of cases it is impossible to differentiate the two from the histological picture. Other types of sarcoma are rarely, if ever, seen.

There is a type of tumor which seems to be limited to the gastro-intestinal tract, histologically resembling carcinoma but clinically benign. This is the so-called carcinoid or argentaffine tumors. The former term is more inclusive, comprising all tumors resembling carcinomas. The latter term is

confined to those which take the silver stain, supposedly because of their origin from cells of the sympathetic nervous system. These tumors most frequently occur in the appendix but are also found in the small intestine. The work of Forbus (5) has done much to elucidate this class of tumors.

Adenomas comprise a large percentage of the tumors found in this series. They arise from the epithelium of the intestinal glands and are, strictly speaking, glandular hyperplasia. A few instances are known of adenomas undergoing malignant change, although this is quite rare. Myomas are more frequently encountered than the figures of this series would lead one to believe. There is nothing unusual about these myomas microscopically, except the enormous number of red blood cells found near the periphery. Intestinal myomas show a striking tendency to bleed, and evidence of this is easily recognized in the section.

The other tumors met with are fibromas, lipomas, hemangiomas, etc., all very similar in microscopic structure to those of the same class occurring in other parts of the body, and offer no diagnostic difficulties when studied histologically.

### III—CLINICAL ASPECTS

Clinical symptoms are dependent largely upon the mechanical condition in the bowel brought about by the tumor, which, in turn, depends upon the size of the growth and its location. The tumors are divided, for convenience, into two classes, those located in the duodenum and those in the jejuno-ileum. Those in the duodenum may produce symptoms by causing obstruction or, as in the case of malignant tumors, by involvement of the surrounding viscera and by cachexia. The same is true to a much lesser extent in the jejuno-ileum. Most tumors in this location cause symptoms by obstruction, complete or partial. Intussusception occurs with sufficient frequency to warrant its considera-

tion as a clinical entity. These tumors are thus classified as those causing obstruction (first, by intussusception, and, second, by pressure or gradual occlusion) and those causing constitutional symptoms.

**DUODENUM** (*benign*).—This group is comprised chiefly of adenomas, myomas, and fibromas. Invagination seldom occurs, and symptoms are brought on by encroachment of the tumor mass upon the lumen, giving rise to a slowly developing obstruction.

*Symptoms: (a) Pain.*—The pain is usually felt in the epigastrium, in some cases more distinctly localized in the right upper quadrant, simulating acute gall-bladder disease. It may or may not be preceded by fullness and discomfort, depending upon the presence and degree of obstruction. It may simulate the pain and burning of a duodenal ulcer when the mucosa is eroded, and occur with greatest intensity two to three hours after meals. In cases of chronic obstruction the attacks may be separated by intervals of complete relief.

*(b) Nausea and vomiting.*—These symptoms precede the onset of pain for from two to five weeks. The vomiting is more pronounced as the obstruction increases. With complete obstruction there is copious watery regurgitation containing particles of undigested food, perhaps bile stained, if the obstruction is below the ampulla of Vater. Dehydration, toxemia and alkalosis, and rapid intense prostration are symptoms secondary to the vomiting and may reach a marked degree. Hematemesis may be present when the tumor has ulcerated, or, according to Goldschmidt (6), in the case of myomas which have a marked tendency to bleed.

*(c) Distention.*—This is one of the frequent and distressing complaints of duodenal obstruction. At first the patient may feel only a sensation of fullness but this later becomes oppressive, and interferes

with respiration, giving the sensation of a constricting band around the lower chest.

(d) *Malaise*.—This is a secondary symptom and may be marked in cases of severe vomiting and dehydration. If hemorrhage has occurred, the symptom is brought on by secondary anemia.

(e) *Loss of weight*.—This is secondary to vomiting and does not reach the severe degree seen in cases of malignancy.

(f) *Diarrhea*.—This is usually present but not marked, and may alternate with constipation.

(g) *Melena*.—The patient frequently gives a history of blood-streaked or tarry stools in cases in which the hemorrhage from the tumor has been moderate or severe. Loss of blood through the bowel may in some cases be so great as to endanger life.

*Physical signs:* (a) *Tenderness*.—This is diffuse as a rule, but may be more intense in the right upper quadrant. It is seldom exquisite and no rigidity is felt.

(b) *Palpation*.—The tumor may be felt in the epigastrium, if it is of sufficient size. Benign tumors are usually loosely attached and are movable.

(c) *Distention*.—This is a marked feature when the obstruction is complete and may be caused largely by a dilated stomach rather than a dilated duodenum. The percussion note is tympanitic.

(d) *Succussion splash*.—This is a valuable sign, when present. It consists of the sound of a splash of fluid, elicited by shaking the body sharply from side to side. It occurs, however, only when there is air present in the fluid. This is one of the most constant signs of gastroduodenal dilatation.

(e) *Temperature, pulse, and respiration*.—These may or may not be slightly elevated as a secondary result of the vomiting and dehydration.

(f) *Blood picture*.—The red cell count and hemoglobin may be low, sometimes no

more than half of the normal value. Extremely low counts are suggestive of malignancy or myomas. The white cell count is not markedly affected but may be slightly elevated when the tumor is necrotic.

(g) *Stools*.—Gross hemorrhage from the duodenum gives the stool a tarry appearance. Smaller traces may be detected by microscopic and chemical examination.

(h) *Vomitus*.—This is thin, watery, and of low specific gravity. It contains particles of undigested food—all that the patient has eaten if the obstruction is complete. If the obstruction is below the entrance of the common duct, the fluid is bile-tinged. The acid content may be high.

(i) *Peristaltic waves*.—These are commonly seen in an emaciated individual when the stomach is grossly dilated.

*Duodenum (malignant)*.—When obstruction, either partial or complete, is present in malignancy of the duodenum, the symptoms are practically the same as with benign tumors, with the addition of the general symptomatology of malignancy such as cachexia, loss of weight, anemia, absence of free hydrochloric acid, etc. Without obstruction, certain features which are fairly characteristic present themselves.

It has always been customary in describing lesions of the duodenum to divide the structure into three portions. The first and third portions may be considered together, since the symptoms are so nearly the same. The second, or peri-ampullary, portion is considered separately and presents certain interesting clinical features.

*Symptoms of the first and third portions.*

(a) *Pain*.—The pain is dull and dragging. It is usually constant and bears no relation to meals, but may be paroxysmal. It is seldom referred, but is diffuse in the epigastrium and may be more intense in the right upper quadrant.

(b) *Nausea and vomiting*.—Nausea is a common feature but follows the pain as a late complication. Vomiting is infrequent

small in amount, and has a flat taste. Often the patient will compare it to a "hard-boiled egg," signifying an absence of free hydrochloric acid. Hematemesis is more common with malignant than with benign tumors, and is frequently seen when erosion has occurred.

(c) *Loss of weight, and cachexia.*—These are marked with malignant tumors as in any part of the gastro-intestinal tract. Frequently the weakness and loss of weight are the first symptoms noticed.

(d) *Constipation and diarrhea.*—Constipation is the general rule but profuse diarrhea was a complaint in several cases.

(e) *Melena.*—The patient frequently gives a history of passing blood in his stools, or of tarry stools. This is caused whenever a tumor erodes the bowel wall sufficiently to produce a gross hemorrhage.

*Physical signs of first and third portions:*

(a) *Tenderness.*—This may be exquisite but is more frequently a soreness, most intense over the tumor mass. It may or may not be accompanied by local rigidity.

(b) *Palpation.*—When the tumor is large enough, a definite mass may be felt. It is commonly fixed by involvement of the surrounding tissues and imparts a sense of resistance to the palpating hand.

(c) *Ascites.*—Fluid may be demonstrated in the abdominal cavity when the growth has extended sufficiently to cause portal obstruction. This usually signifies metastases.

(d) *Gastric analysis.*—Chemical examination commonly reveals low or absent free hydrochloric acid.

(e) *Stools.*—Blood is usually demonstrated in the stools either by gross or chemical examination.

(f) *Blood picture.*—A profound secondary anemia is sometimes seen in advanced stages. The white cell count is moderately elevated, but may be quite mark-

edly elevated if the tumor has been secondarily infected.

(g) *Temperature, pulse, and respiration.*—There is nothing remarkable about these values unless moderately elevated as a secondary result of the anemia and cachexia.

*Symptoms and signs of the second and peri-ampullary portion.*—The symptoms and signs of malignant tumors in this region, which usually involves the ampulla of Vater, are similar in general to those of tumors in the first and third parts. There are, however, the following additional features:

(a) *Pain.*—This may be more acute and be centered near the mid-line. It occurs when the growth has caused an occlusion of the mouth of the ampulla and bile is forced by back-pressure into the pancreatic ducts, setting up a chemical irritation of that organ. Fatty necrosis may be a later complication from stasis of the pancreatic secretions.

(b) *Jaundice.*—This usually appears early and is painless. It may be the first symptom, progressing rapidly without remission. It is accompanied by intense itching.

(c) *Stools.*—The feces are clay-colored when the ampulla is completely blocked. Chemical test shows absence of bile pigments.

Carcinoma of the ampulla is practically impossible to distinguish from carcinoma of the head of the pancreas. It is rapidly progressive and terminates in early death in nearly every instance.

*Diagnosis of duodenal tumors:* (1) *Carcinoma of the pylorus.*—This may simulate closely an obstructive malignancy of the duodenum, but the symptoms come more gradually in the former.

(2) *Duodenal ulcer.*—This may be a source of confusion in certain cases. Carcinoma of the duodenum, however, causes

an absence of free hydrochloric acid in the stomach contents, is more acute than duodenal ulcer, has not the same periodicity, and the pain is less sharp.

(3) *Tumor of the pylorus herniating into the duodenum* rarely simulates a duodenal tumor and sometimes can be distinguished by X-ray examination, but usually the condition is not recognized until operation.

(4) *Carcinoma of the head of the pancreas*.—This is practically indistinguishable from carcinoma arising in the ampulla of Vater, except at the operating table.

(5) *Angiomesenteric ileus*.—Acute dilatation of the duodenum brought about by occlusion caused by traction from the superior mesenteric vessel is more acute in onset than in symptoms: it is usually post-operative, and may be relieved by placing the patient in the Trendelenburg position.

(6) *Chronic duodenal dilatation* by constricting bands of adhesions is difficult to distinguish from dilatation due to a benign tumor. Frequently there is a history of upper abdominal disturbances or surgical interference.

(7) *Acute gall-bladder disease* may sometimes be considered when the pain is localized in the right upper quadrant. The absence of other biliary symptoms should make the diagnosis clear.

**TUMORS OF THE JEJUNO-ILEUM.**—Obstruction is by far the most common result of a tumor in this part of the intestine. Symptoms, therefore, should be referable to that condition. There are a few tumors, however, mainly malignant ones, which do not cause obstruction and produce symptoms only through their systemic effects. These are quite obscure and present a most difficult problem of diagnosis. "Obstructive and Non-obstructive Tumors" is a convenient classification, therefore, from the standpoint of symptomatology.

(A) *Obstructive tumors*.—Obstruction may be brought about by intussusception and by encroachment of the tumor upon the lumen. These tumors deserve separate consideration in that certain features are widely different.

(1) *Intussusception*.—Intussusception occurs in 30 per cent of the tumors found in the jejunum and ileum, according to Staemmler (7). The figures for this group were slightly less, namely, 23 per cent. The condition was found to occur only one-third as frequently as in malignant tumors.

This type of intussusception differs from that found in children. It is spontaneous and thought to be caused by a hyperactive gut. In these patients, the explanation commonly assumed is the gripping of a tumor, usually pedicled, by the peristaltic waves, by which a section of the gut is telescoped bodily inside of a section lower down, the tumor always remaining at the apex of the intussuscepted piece of bowel. Spontaneous reduction is much less common than in the acute intussusception of children, although it does occur. It may later recur and become chronic, marked by periods of almost complete relief from symptoms.

*Symptoms:* (a) *Pain*.—The onset of intussusception is marked by a sudden, sharp, agonizing pain, which does not begin to abate until some hours later. It is fairly well localized, usually in one or the other lower quadrant, most frequently the left. If the intussusception is reduced spontaneously, the pain ceases immediately. This is not likely to occur after the first twelve hours, as adhesions will have formed between the serous surfaces of the gut wall, and surgical intervention will be indicated. The symptoms may abate after awhile, only to recur again and again.

(b) *Vomiting*.—This is one of the first symptoms, following shortly after the onset of pain. It is occasionally repeated, but seldom becomes stercoraceous or retching.



(c) *Stools*.—The bowels below the obstruction become emptied after a time. Soon after, tenesmus begins and small amounts of bloody mucus are passed at frequent intervals, arising from the squeezed and constricted portion of the intussusceptum. No further free bowel movements occur after the condition is well established.

(d) *Shock*.—This does not develop at first but in all probability will be established by the time the clinician reaches the patient.

(e) *Distention*.—This develops after a few hours and is not so marked as in other types of intestinal obstruction. In some cases it is absent altogether, while in others it may be a marked and distressing symptom.

(f) *Mass in abdomen*.—Frequently the patient may state that he has felt a mass develop in one of the lower quadrants, some hours after the onset of pain and vomiting, and when the abatement of the latter symptoms have given him a sense of false security.

*Physical signs: (a) Palpation*.—The abdomen is slightly distended but not markedly tympanitic. In extreme cases peristaltic waves may be seen. Tenderness is not a marked feature. Palpation of a mass is fairly constant: it is caused by the telescoped bowel and is more easily palpable as the condition progresses. It is sausage-shaped and hard and rigid during the attacks of pain; most commonly located in one of the lower quadrants but occasionally it may be felt in the region of the transverse colon. It is slightly tender but not exquisitely so, and may change in size and position from day to day as the intussusception progresses.

(b) *Appearance*.—The patient may reach a state of shock late in the course of the attack. The skin will be cold, clammy, and pallid and the patient apathetic. If the condition is chronic and of long standing, the patient may be emaciated.

(c) *Temperature, pulse, and respiration*.—These data are especially valuable in determining the presence of shock. If shock is present, the pulse will be rapid, thready, and of poor volume. Respirations will be rapid and shallow. The temperature is usually subnormal.

(d) *Blood examination*.—The red cells and hemoglobin usually indicate a moderate degree of secondary anemia. The leukocyte count is moderately elevated.

(e) *Stools*.—Blood and mucus in small amounts comprise the bowel movements. The former is easily detected in the gross and is a nearly constant finding.

(f) *Vomitus*.—Vomiting is not copious and the fluid is thick and bile-stained. Occasionally it is stercoraceous, if the intussusception is low in the intestinal tract.

(2) *Encroachment upon the lumen*.—This may occur by constriction of the lumen by a malignant growth encircling the gut, by an internal tumor protruding gradually into the lumen, or by pressure from the outside by a neoplasm of the external form. Malignant tumors usually cause symptoms by constriction or pressure: benign, more frequently by protrusion and filling of the lumen—the mode of production is mechanically different, but the result and symptoms are essentially the same. The rapidity of growth is naturally more marked in malignant tumors, and the patient shows the characteristic systemic features of a malignancy.

*Symptoms*.—The mode of onset is much more gradual than is the case with intussusception. The patient may feel "below par" for a number of months before symptoms of actual obstruction set in.

(a) *Pain*.—The pain is commonly diffuse in the lower abdomen, but may sometimes be confined to one or the other lower quadrant. In a few cases, the diagnosis of appendicitis was made. In still other cases, pain localized about the umbilicus. It is most frequently dull and aching; at other

times, sharp and cramp-like. In any event, there is a slow increase in the intensity of the pain, with few or no remissions.

(b) *Distention*.—This is not a characteristic feature in all the cases, but the patient often complains of a bloating sensation after meals. Rarely does it become significant until obstruction is complete.

(c) *Nausea and vomiting*.—These symptoms are not marked, but fairly constant. They appear late, the nausea preceding the vomiting. The patient believes that eating is responsible, and attributes the upset to his "run-down condition." Vomiting recurs at intervals of a week or two, but is more frequent and serious when no obstruction is located high in the jejunum.

(d) *Malaise*.—Always more marked in malignant tumors, this is the first symptom noticed by the patient. He feels "run down," tires easily, and is generally "below par." Anorexia may become marked, and, if the patient does not force himself to eat, a serious and progressive loss of weight may ensue.

(e) *Stools*.—Constipation is commonly marked and may have been present for a number of years. Blood, either gross or microscopic, may be present, and is more apt to appear in cases of myomas and ulcerating malignant growths.

(f) *Mass*.—If the tumor is large enough, the patient may complain of a mass which he has felt increasing gradually in size for some time. Malignant tumors are more apt to be noticed subjectively, as their growth is more rapid and more apparent.

*Physical signs:* (a) *General appearance*.—When the physician is consulted, the picture is that of a chronic partial obstruction. The patient is a cachectic individual, under-weight and under-nourished. He is pale, especially in malignant conditions, and emaciated in extreme cases.

(b) *Tenderness*.—There may be slight tenderness over the tumor mass in some

cases, but it is seldom widespread or exquisite.

(c) *Palpation*.—A mass is felt if the tumor has attained sufficient size; in other cases, an indefinite sense of resistance is encountered. Voluntary muscle spasm is occasionally present but no actual rigidity.

(d) *Distention and tympanites*.—A slight fullness may be noted in the earlier stages of obstruction, but marked distention does not appear until the obstruction is complete.

(e) *Blood picture*.—A secondary anemia is the rule with malignant tumors, less constant with benign. It may reach a severe degree if there has been profuse hemorrhage from the bowel—even to the point of endangering life. The leukocyte count is not constant but tends to be slightly elevated.

(f) *Stools*.—Blood, either microscopic or gross, may be demonstrated, more constantly in malignant tumors and myomas.

(B) *Non-obstructive tumors*.—There is a small group of tumors which, by growing away from the lumen of the intestine into a free cavity, do not produce a mechanical obstruction, and consequently the symptoms are dependent entirely upon toxicity and pressure. The clinical picture is most obscure and no hint of the condition is gained until the tumor is large enough to be palpated. The neoplasms of this group are most commonly malignant (carcinomas), although numbers of the chronic inflammatory group of lesions are sometimes found.

*Symptoms:* *Malaise*.—This is the first and practically the only symptom noticed by the patient. He tires easily and may become short of breath upon slight exertion. The pulse rate may be slightly irregular, and slight loss of weight and anorexia soon appear. The physician is sought, but nothing that will account for the symptoms is found. The condition progresses steadily until the

(c) *Stools*.—The bowels below the obstruction become emptied after a time. Soon after, tenesmus begins and small amounts of bloody mucus are passed at frequent intervals, arising from the squeezed and constricted portion of the intussusceptum. No further free bowel movements occur after the condition is well established.

(d) *Shock*.—This does not develop at first but in all probability will be established by the time the clinician reaches the patient.

(e) *Distention*.—This develops after a few hours and is not so marked as in other types of intestinal obstruction. In some cases it is absent altogether, while in others it may be a marked and distressing symptom.

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(c) *Temperature, pulse, and respiration*.—These data are especially valuable in determining the presence of shock. If shock is present, the pulse will be rapid, thready, and of poor volume. Respirations will be rapid and shallow. The temperature is usually subnormal.

(d) *Blood examination*.—The red cells and hemoglobin usually indicate a moderate degree of secondary anemia. The leukocyte count is moderately elevated.

(e) *Stools*.—Blood and mucus in small amounts comprise the bowel movements. The former is easily detected in the gross and is a nearly constant finding.

(f) *Vomitus*.—Vomiting is not copious and the fluid is thick and bile-stained. Occasionally it is stercoraceous, if the intussusception is low in the intestinal tract.

(2) *Encroachment upon the lumen*.—This may occur by constriction of the lumen by a malignant growth encircling the gut, by an internal tumor protruding gradually into the lumen, or by pressure from the outside by a neoplasm of the external form. Malignant tumors usually cause symptoms by constriction or pressure: benign, more frequently by protrusion and filling of the lumen—the mode of production is mechanically different, but the result and symptoms are essentially the same. The rapidity of growth is naturally more marked in malignant tumors, and the patient shows the characteristic systemic features of a malignancy.

*Symptoms*.—The mode of onset is much more gradual than is the case with intussusception. The patient may feel "below par" for a number of months before symptoms of actual obstruction set in.

(a) *Pain*.—The pain is commonly diffuse in the lower abdomen, but may sometimes be confined to one or the other lower quadrant. In a few cases, the diagnosis of appendicitis was made. In still other cases, pain localized about the umbilicus. It is most frequently dull and aching; at other

susception. In either event, there is dilatation of the duodenum above that point, greater when the obstruction is complete. This shows in the X-ray film after a barium meal as a large dense shadow following the general contour and direction of the duodenum to the point of obstruction. Finger-like projections of the barium shadow may also be seen in the dilated crypts of Lieberkühn. One is justified, in such a case, in diagnosing obstruction, which in the majority of cases is due to a tumor. If the obstruction occurs in the third portion of the duodenum, however, it is apt to be confused with gastromesenteric ileus. Six-hour gastric retention as shown in the gastro-intestinal series is, according to Golden (1), strongly indicative of a duodenal tumor.

(2) *Filling defect*.—Carcinomas which are early and have produced an erosion in the duodenal wall give a picture strongly resembling that of duodenal ulcer. The similarity may be so great that it is impossible to distinguish between the two, and one is forced to rely upon clinical data, the history of onset, and gastric acidity. The defect is usually a small irregular crater and may occur in any part of the duodenum. Quite frequently found in the region of the ampulla, it is valuable in differentiating early carcinoma of the ampulla from carcinoma of the head of the pancreas.

(3) *Encroachment upon the lumen*.—Constricting malignant growths are sometimes seen in the X-ray film as indentations upon the barium shadow from both sides. In the earlier stages this may not be marked, and there may be no dilatation. As the constriction continues and obstruction increases, dilatation begins to appear, and a large shadow is seen proximal to the growth, with a tiny thread of barium trickling through.

A solitary tumor nodule developing in the wall of the duodenum may be revealed as an indentation in the barium shadow, if it is of sufficient size. It is impossible in this

case, however, to say whether the tumor is benign or malignant. In the constricting form, the evidence is in favor of malignancy. There is occasionally seen a decrease in the density of the barium shadow which is not a true indentation, and one receives the impression that the tumor causing it is not continuous with the wall but is floating loose in the lumen. These are usually papillomas at the end of a pedicle; when observed by the fluoroscope they may be seen to change position. On rare occasions bits of barium may be seen to stick in the crevices of the papilloma after the rest of the barium meal has passed on through the duodenum.

*Jejunum and proximal ileum*.—This is the part of the small intestine which is movable, and, while it conforms to the general divisions described by Mall (8), it is extremely difficult to locate a lesion by X-ray examination.

(1) *Dilatation*.—This is the type of lesion most frequently seen. It is caused by an obstruction and may be found anywhere in the cavity occupied by the intestines. A considerable length of intestine may be dilated, and, following the barium meal, the shadow may appear in large, dense, irregular coils. As the barium settles, the shadow will be shorter and bulbous, ending at the point of obstruction; or, if the obstruction is not complete, a thin ribbon of barium may trickle through. Even this may change position with subsequent examinations, unless the growth has fixed it to the abdominal wall.

Very little can be determined regarding the character of the lesion from the X-ray findings, and in those cases which produce no obstruction it is futile to attempt a diagnosis.

(2) *Dense shadow*.—The tumor will sometimes be visible in a flat plate of the abdomen without a barium meal. It will be seen merely as a large irregular shadow,

visible only when the tumor is large and the consistency dense. This cannot justify a diagnosis alone, since there are many other conditions which may cast the same type of shadow. In conjunction with positive clinical data, however, it gives a valuable lead.

*Terminal ileum.*—This is the site of predilection for tumors of the chronic inflammatory group and lymphosarcoma. The reason for this is not certain, but the excessive lymphoid tissue in this region, the so-called Peyer's patches, evidently predisposes to this type of tumor.

(1) *Dilatation.*—Obstruction is the most frequent lesion, causing a dilatation of the gut above the tumor similar in every way to that described in the previous group, except that the shadow is more constantly fixed. The barium meal shows a bulbous dilatation of the ileum down to the point of obstruction. The barium enema discloses a partially collapsed large intestine. The barium flows up to the point of obstruction and then stops. When such a picture is constantly in the right lower quadrant in two or more positions, one is reasonably justified in placing the tumor in the lower ileum.

(2) *Filling defect.*—Occasional cases may show a slight defect in the lower ileum. This is not constant, but when it does appear and is confirmed by subsequent X-ray examination, it offers a diagnostic point. A more constant finding is an incompletely filled cecum. This may be due to involvement of the cecum or to pressure upon it from the outside by the mass in the ileum. A third condition preventing filling of the cecum is an intussusception of the ileum into the cecum. These findings are not infallible; it is seldom possible to decide the site of the original growth, whether primary in the cecum or ileum.

(3) *Dense shadow.*—This finding bears the same significance as when found in the jejuno-ileum. It is caused by a large tumor

of dense consistency, and changes position very little, if at all, in repeated films.

(4) *Pseudodiverticulum.*—Soper (2) has emphasized the appearance of a shadow resembling that produced by a true diverticulum, in large eroded carcinomas. The shadow in the latter is more irregular and frequently a gas bubble is seen at the highest portion of the cavity. However, no cases of this type have been encountered in this series of tumors.

#### V.—CASE REPORTS

Case I.—E. L. (Fig. 1), a white male, aged 52, came to the hospital complaining of epigastric pain and recurrent vomiting of three months' duration. The symptoms had increased during the past few weeks, and when admitted to the hospital he was vomiting everything eaten and suffering from severe abdominal cramps. Physical examination showed marked tenderness of the epigastrium and visible peristaltic waves. He frequently vomited small amounts of bile-stained fluid. X-ray examination following a barium meal revealed marked dilatation of the duodenum throughout its whole length, and moderate dilatation of the stomach. The seat of obstruction was thought to be near the duodenojejunal junction.

At operation, a firm sessile tumor  $9.5 \times 4.5 \times 3.5$  cm., projecting into the lumen and covered by a freely movable intact mucous membrane, was removed from the distal third of the duodenum. Histological examination showed it to be a fibroma, composed of adult fibroblasts.

Recovery was uneventful and the patient was discharged completely well. Sixteen months later he reported for re-examination in excellent health.

Case II.—T. S. (Fig. 2), a white male, aged 68, was admitted to the Union Memorial Hospital complaining of a growing pain in the epigastrium of six weeks' dura-

tion. Six months previously he had first noticed a gradually increasing fullness in the epigastrium. Actual pain began three weeks before admission and was most intense two to three hours after meals. He had lost seven pounds in three months. Physical examination showed a questionable mass in the right upper quadrant which was not tender. X-ray films showed moderate dilatation of the first part of the duodenum, below which there was an area of decreased density in the barium shadow. The diagnosis of benign papilloma of the duodenum was made, and the patient underwent a laparotomy. At operation, a long papillary cauliflower-like tumor was found attached by a thick pedicle on the duodenal side of the pylorus. Microscopical examination showed it to be a typical glandular hyperplasia and in one part of the tumor malignant degeneration had set in.

Following operation, the patient developed signs of peritonitis and died on the fourth day after operation.

Case III.—C. L., a white female, aged 19, came to the hospital complaining of weakness of several years' duration. She had had a "blood tumor" removed from the tongue at the age of seven years. She had been treated for anemia, with little more than temporary improvement. During the past year she had complained of gaseous eructation and constipation. She was a thin, very pale individual. Physical examination was otherwise negative. The blood examination revealed a profound secondary anemia: red blood count was 1,860,000; hemoglobin 19 per cent. Stools were black and strongly positive for blood. X-ray examination showed a suggested filling defect in the second portion of the duodenum. The condition was thought to be due to a tumor of the duodenum in the presence of an obscure anemia, and a blood transfusion was given in preparation for operation.

At operation, a rounded nodule 2 cm. in diameter was found involving the mucosa



Fig. 1. Roentgenogram following barium meal. The stomach and duodenum are enormously dilated and the valvulae conniventes can be seen plainly. The site of the lesion was placed near the duodenojejunal junction. No actual filling defect can be seen. (Dr. Dean Lewis' case.)

and submucosa of the second third of the duodenum. The tumor was dark red on section and oozed blood. Microscopic section showed numerous sinuses containing many red cells. Diagnosis, hemangioma duodenum.

The tumor was excised and the patient's recovery was uncomplicated. Stools were free from blood for several days, but it reappeared and was present at the last report, six weeks after operation, although the general condition of the patient was improved.

Case IV.—E. B., colored male, aged 60, was admitted to the hospital complaining of indigestion, weakness, and anorexia. Symptoms had developed over a period of six months. He had lost a moderate amount of weight. Epigastric pain, intensified by eating, had developed, and he vomited frequently. The vomitus on a few occasions

contained old blood. Constipation was marked.

He was a poorly nourished colored man, somewhat under-weight, and showing moderate pallor of the mucous membranes. The

most complete obstruction. The ileum above the obstruction was tremendously dilated and below it was collapsed. Histological examination showed a dense collection of small round cells, similar to those of the

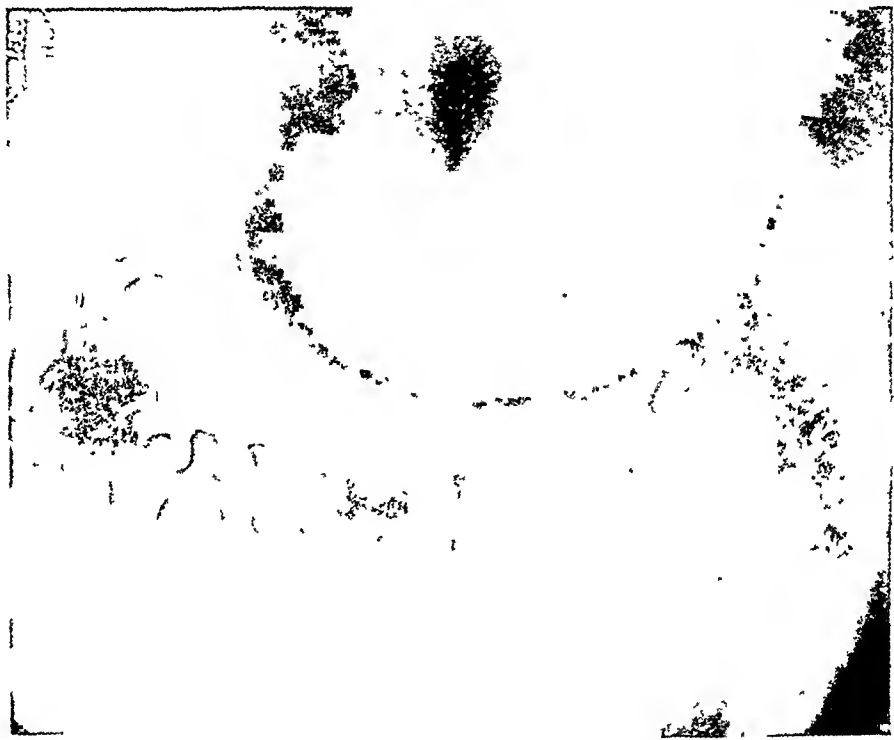


Fig 2 Roentgenogram following barium meal The stomach is moderately dilated and there is a bulbous dilatation of the first part of the duodenum, with a decrease in the intensity of the shadow Distal to this there is an entire absence of barium shadow A malignant papilloma was removed at operation from the first portion of the duodenum. (Patient of Dr. J. M T. Finney, Sr Material for photograph obtained through the courtesy of Dr Finney and Dr Charles A Waters )

abdomen was distended and active peristaltic waves were seen in the hypogastric and iliac regions. An indefinite sense of resistance was encountered in the epigastrium.

The X-ray film showed enormously dilated coils of small intestine, but the point of obstruction could not be determined. A barium enema showed no defect in the large intestine. The diagnosis of obstruction in the small intestine was made, and exploratory laparotomy advised.

At operation, a constricting tumor the size of an English walnut was found four feet above the ileocecal valve, causing al-

lymphocytic series. The neighboring glands were enlarged, but soft, and showed no sign of malignancy. Diagnosis, chronic inflammatory tumor of the ileum.

Case V.—U. M. (Fig. 3), a white male, aged 69, came to the hospital complaining of indigestion and general malaise. He had felt "below par" for several months. Ten days previously he had noticed some irregularity of his pulse and for the last week he had had moderate indigestion, with intermittent attacks of dull abdominal pain. On physical examination a dense irregular mass the size of a grapefruit was found in

the lower left quadrant. X-ray examination showed moderate dilatation of the loops of the ileum, with evidences of partial obstruction.

Exploratory laparotomy was performed and a large abscess found attached to the

tissue was removed for diagnosis. Microscopic section showed small round cells, similar to those of the lymphocytic series, closely packed together, but with the appearance of malignancy. Diagnosis, sarcoma of the ileum.



Fig 3 Roentgenogram of small intestine and colon following barium meal and barium enema. The large intestine is completely filled. The lowest coil of the ileum can be made out and is moderately dilated in the terminal portion before it passes into an area of constriction just proximal to the ileocecal valve. A tiny, thread-like stream of barium can be seen entering the cecum. (X-ray film obtained through the courtesy of the Union Memorial Hospital.)

ileum. It was evacuated and drained and a communication found between the intestinal lumen and the abscess cavity. Culture from the abscess grew *B. coli*. A piece of

The patient developed peritonitis and died five days after the operation.

Case VI—A. P., colored female, aged 46, came to the hospital complaining of gen-



eral malaise for six months; intermittent, cramp-like, diffuse pains in abdomen; profuse diarrhea for three months; nausea and vomiting for several days, four or five times a day. The patient was anemic and complained of the most intense pain in the right lower quadrant. There was some voluntary rigidity. An irregular, tender mass in the right lower quadrant was felt on rectal examination, external to the rectum and seeming to be fairly well fixed. Red blood count was 3,290,000; hemoglobin 72 per cent; free hydrochloric acid, 0. X-ray examination showed the sigmoid to be pulled to the right and the cecum incompletely filled. The pre-operative impression was that this was a case of intestinal obstruction due to malignancy at the ileocecal junction.

At operation, an annular growth was found constricting the ileum 13 cm. above the valve, but lying against the cecum and compressing it. Resection was done and the ileum anastomosed to the cecum. Microscopic section showed large malignant cells of the epithelial type. Diagnosis, carcinoma of the ileum.

The patient recovered from the operation and was discharged as improved. When last seen, six weeks after the operation, she had a discharging sinus. Further follow-up was impossible as the patient left the city.

Case VII.—C. H., colored male, aged 68, was admitted to the hospital with the complaint of cramp-like pains in the abdomen, anorexia, vomiting, and constipation developing and progressing over a period of six months. He had lost forty pounds in weight. At times he had felt a lump the size of a hen's egg in the right lower quadrant. He was an emaciated old negro man, with distinct pallor of the mucous membranes. A sausage-shaped tumor mass was felt in the right lower quadrant, appearing and disappearing with loud gurgling sounds. Upon rectal examination a small hard mass could be felt outside the rectum, high up on

the right. Occasional peristaltic waves could be seen coincident with the attacks of pain. The blood showed a moderate secondary anemia. Stools were negative for blood. There was no free hydrochloric acid in the gastric contents. X-ray examination showed an obstruction at the ileocecal junction which suggested a malignant process. The condition was diagnosed as intestinal obstruction due to a neoplasm of the colon, and a laparotomy was performed. A hard, cartilaginous, annular tumor was found 20 cm. above the ileocecal valve, causing partial obstruction of the lumen. It was resected and a lateral entero-enterostomy performed.

Following operation, the patient developed generalized peritonitis and died two days later.

Microscopic section showed a tumor composed of large malignant epithelial cells. Diagnosis, carcinoma of the ileum.

Case VIII.—G. S., white male, aged 37, came to the hospital complaining of pain in the right side. Eight months before he had felt something give way inside his abdomen following a strain. He began to feel ill, lost weight, became nauseated, and vomited at intervals. He occasionally noticed that his stools were blood-streaked. There was a period of remission during which he was almost entirely free from symptoms, but seven weeks before admission the pain had returned and later he began to vomit frequently and was constipated.

Physical examination showed a pale, emaciated white man. Findings were negative except for a rounded, movable mass in the right lower quadrant, which was tender to pressure. He had a severe secondary anemia, but stools were negative for blood. The X-ray film showed a filling defect a short way above the cecum. It was diagnosed as neoplasm of the ascending colon, and a laparotomy was performed. At operation, a hard, annular, constricting tumor was found encircling the ileum 4 cm. above the

valve. It had intussuscepted into the cecum, producing a partial obstruction, but the overlying mucosa was intact. The cecum and terminal ileum were resected and an ileocolostomy performed. Recovery was uncomplicated and he was discharged as improved. Histologically, the tumor was composed of small round cells densely packed together. They did not have the general appearance of malignancy. Diagnosis, chronic inflammatory tumor.

#### SUMMARY

Eighty-two tumors, occurring in the small intestine between the pylorus and ileocecal valve, have been found in the records of the Surgical Pathological Laboratory of the Johns Hopkins Hospital. Of this number, 40 per cent were malignant and 60 per cent were benign. Only 51 per cent showed symptoms, the remainder being found at autopsy. Those giving symptoms have been studied in an attempt to classify the tumor according to the symptomatology. It was found that the symptoms produced varied according to the mechanical condition produced in the bowel, which in the majority of cases was obstruction.

Malignant tumors showed the superimposed effect of any gastro-intestinal malignancy, namely, cachexia, loss of weight, and anemia.

Tumors of the duodenum produced symptoms more acutely than lower in the intestine, and were frequently confused with tumors of the stomach and ulcers of the duodenum.

Absence of free hydrochloric acid in the gastric contents in the presence of carcinoma of the small intestine occurs so nearly constantly as to make it an important diagnostic feature.

The presence of occult blood following a meat-free diet is important, and, if repeatedly positive, is of great significance.

X-ray examination offers the best positive means of diagnosis, but it is not infallible. Negative findings do not rule out a lesion; positive findings do not necessarily indicate a tumor. Only when used in conjunction with important clinical data can its worth be evaluated. The X-ray examination should include a flat film of the abdomen and a barium enema, in addition to the regular gastro-intestinal series. The greatest care should be exercised in making and examining the films, and any doubtful finding checked by repeating the examination.

#### CONCLUSIONS

The symptomatology of tumors of the small intestine is at best an obscure subject. Due to the paucity of material the clinician is unable to compare case reports and formulate a working standard. The rarity of such tumors has discouraged correct diagnoses on some occasions simply by the laws of chance. Not more than half of this group of neoplasms studied in this clinic caused symptoms. These cases, 42 in number, have been studied meticulously with regard to the clinical manifestations and an attempt has been made to provide a working basis for diagnosis.

The findings correspond roughly to those of other gastro-intestinal tumors, especially in the laboratory tests. Localization is the most difficult. The X-ray examination is invaluable in this respect and one should never neglect to do a thorough roentgenologic study of the whole gastro-intestinal tract if the clinical symptoms point to a tumor in this system. Even under these circumstances, the X-ray is not infallible. Lesions seen in the roentgenogram should be compared with the other laboratory findings, especially the finding of occult blood in the stool, and evaluated in respect to these findings.

Emphasis should be placed on a thorough and careful investigation by these means of examination in every case in which the diagnosis is obscure. The correct diagnosis will by no means be made in every case but it should materially aid the surgeon in recognizing the stage of advancement of the lesion, thereby giving the patient the advantage of an early operation, or, if the condition is hopelessly advanced, prevent him from undergoing a useless and discomforting laparotomy.

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## THE REPORT OF FIVE CASES OF SUBACUTE OSTEOMYELITIS OF THE FEMUR RESEMBLING SARCOMA

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WHILE osteomyelitis in the majority of cases is a disease of childhood, there is a slow subacute type which may appear at any age. In this type the process may go on for a long time, the result being an osseous formation quite difficult to differentiate from sarcoma. The causative agent in practically all the cases is an attenuated organism of low virulence, which has been present in the system for a long period of time. The patient gains a certain amount of resistance against this organism, the result being a subacute rather than an acute type of osteomyelitis.



Fig 1-A Case 1. Roentgenogram showing a thickening of the periosteum and a slight sclerosis of the medullary cavity. The patient had infected tonsils and cloudy sinuses, with a white blood count of 14,000

Fig. 1-B Same case as shown in Figure 1-A. A second X-ray film, taken one year later, showing the complete healing of the lesion.



Fig. 2 Case 2 Roentgenogram showing new bone formation and bone destruction somewhat suggestive of sarcoma. Exploration showed granulation tissue only.

Because of the great difficulty in reaching a correct diagnosis and because the treatment depends so entirely upon the correct diagnosis, every means at one's disposal must be used to arrive at this important decision. A few days' delay will not affect the results. As in all bone lesions, the burden of proof should be to demonstrate the malignancy of the condition. A very careful history should be taken, a careful

search made for a history of injury or of any acute infection, and above all an exhaustive examination must be carried out to locate any possible foci, however slight.

A number of cases have entered the clinic in which a differential diagnosis has been exceedingly difficult. Some patients with an initial diagnosis of sarcoma are well to-day without radical treatment of any kind.

In this group of cases, which is being reported as a group for the first time, there is a history of injury in two, bad teeth in one, a carbuncle in one, and osteomyelitis ten years before admission in another.

In all these cases pain in and an enlargement of the part affected were the symptoms of the onset, and in all cases the femur has been involved. A leukocytosis in all but one case has been present, while the Wassermann was negative in all.

Case 1.—Three months before entering the clinic the patient had an attack of "sciatica," affecting the right leg. Five teeth were extracted and the back was strapped. A few weeks later he noticed soreness and swelling of the right thigh. Two weeks later he had more pain and swelling. The diagnosis of osteogenic sarcoma was made by an outside doctor.

*Examination.*—The right thigh is much larger than the left and there seems to be a thickness of the femur at the upper and middle third. This thickness almost surrounds the entire femur. It is not tender.

Tonsils infected and sinuses cloudy. White blood count 14,000. Wassermann negative.

X-ray examination of chest negative. X-ray film shows a thickening of the periosteum but no real breaking through. There is a slight shadow in the medullary cavity and a tiny calcified spot about one and a half inches from the femur. This does not impress one as a malignant lesion, but, rather, as a benign infective process of osteomyelitis.

The patient was kept at rest. The tonsils

were removed and a submucous resection of the septum done.

Three months after we saw him, a sequestrum about 8 by 3 mm. was removed from

A second X-ray film made one year later shows the bone lesion to be entirely healed and the femur normal.

The final diagnosis was osteomyelitis,

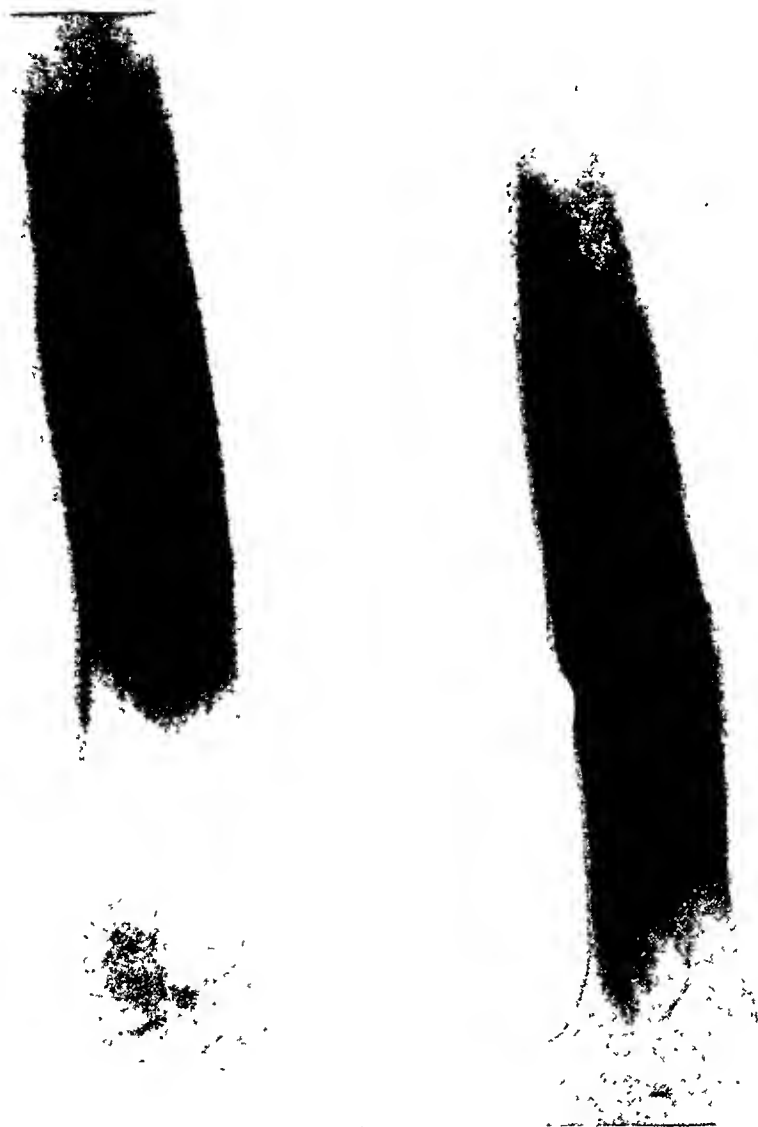


Fig. 3. Case 3. Antero-posterior and lateral views, showing marked sclerosis in the middle third of the femur, with suggestive sequestrum and involucrum. One year later a small piece of bone was removed in a pocket of pus at the site of the indentation shown in the film. The white count was 16,500.

the thigh. No gross pus was found at operation. Microscopic section did not show any sarcomatous change. Culture of tissue removed showed *Staphylococcus aureus*.

subacute type, with ossifying periostitis. This patient is perfectly well, two years later.

Case 2.—Patient is a white male, aged 42. Five months before admission to the

clinic, the patient had a carbuncle on the lower portion of the left thigh which healed in two weeks. Following this, severe pain in the same leg developed, diagnosed and treated as "rheumatism."

and tissue was removed. Microscopic section at this time showed new bone formation, with vascular cellular tissue between the bone and lamellæ, more typical of an inflammatory reaction than of a sarcoma.



Fig. 4-A. Case 4. Roentgenogram showing periosteal new bone formation in the upper femur, suggestive of early sarcoma. This film was made in January, 1924.



Fig. 4-B. Roentgenogram showing increased sclerosis and a shrinking in the periosteal new bone. This film was made in April, 1925, after a course of X-ray therapy had been administered.

On examination the left upper leg is found to be swollen about the middle third, tapering toward both the knee and the hip joints. The swelling extends around the entire leg, is rather hard, and gives the impression of bone formation. Wassermann negative. No temperature and no increase in leukocyte count.

X-ray examination shows new bone formation and bone destruction, chiefly on the medial side of the cortical bone, and some involvement of the marrow cavity. The X-ray findings suggest periosteal sarcoma.

Through fear of amputation, the patient left the hospital before operation. He later entered a hospital in Philadelphia, where exploration was done and a small piece of bone

This patient, following rest and hospital care after operation, made an uneventful recovery. The final diagnosis was osteomyelitis, subacute in type, with ossifying periostitis of the upper end of the femur.

X-ray examination three years after operation showed a healed bone lesion. Seven years later the patient was well.

Case 3.—The patient was a white male, aged 18. Sixteen months before X-ray films were received for diagnosis, the boy had hurt his leg while wrestling. His leg was sore for one or two days; there was no fever and no swelling; pain on pressure over right femur was noted. Following this injury, he worked as a plumber's helper and also danced for long periods of time. His leg began to hurt and was quite painful



Fig. 4-C. Roentgenogram of the arrested lesion, made in December, 1926, after further X-ray treatment. Same case as shown in Figures 4-A and 4-B

after an all-night dance. Some slight fever and temperature resulted.

Examination of the boy showed some swelling over the right femur and some bony thickening, which seemed to extend completely around the femur. There was also a definite bulging of the soft parts in an irregular manner.

The X-ray film made after his first injury showed no bone change at all. X-ray films made after his second attack showed a very marked bony thickening of the mid-

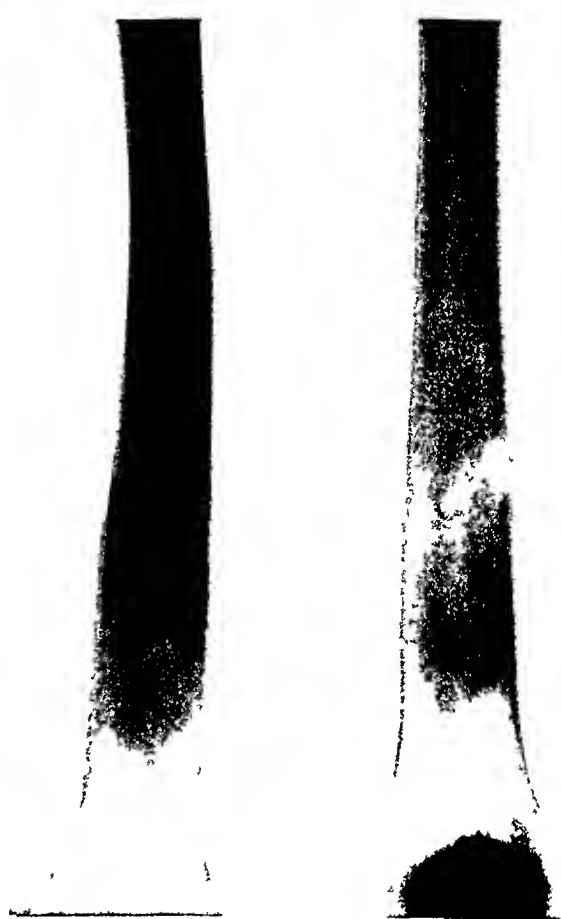


Fig. 5-A. Case 5. Roentgenogram showing bone sclerosis and periosteal roughening in the right femur in a patient who had had osteomyelitis nine years previously (with apparent healing) in the right tibia.

dle third of the femur. It looked as though an involucrum and a sequestrum were present in the center of the shaft. The sequestrum seemed almost detached. There was some spicule formation along the outer border of the involucrum. This resembled a picture of osteomyelitis more than a sarcoma. Such light areas are rarely seen in sarcoma. At the lower end of the femur there was a definite bone cyst. The white blood count was 16,500; the blood Wassermann was negative. One year later X-ray examination showed a small piece of bone becoming detached, but no definite change in the main mass. Operation for removal of the small pieces of bone was performed.



Following the removal of two more detached pieces of bone a sinus developed, and this gradually healed without loss of more bone. Five years after his original attack the patient is well. The final diagnosis was osteomyelitis of the subacute type in the right femur.

Case 4.—The patient was a white male, aged 18, who was injured in a football game one month before admission. At this time he had a slight limp and complained of a great deal of pain, particularly at night. There was no swelling. He had been treated by an osteopath for three weeks, following which treatment there was some swelling.

The blood Wassermann was negative, and the white blood count was 15,850. On palpation we could feel a mass at the junction of the upper and middle third of the left femur, most marked on the lateral surface.

X-ray examination showed a definite soft-part tumor without bone. A definite area of destruction in the cortical layer beneath the new bone formation was visible. The new formation surrounding the entire shaft was suggestive of periostitis, and the marrow cavity was very suggestive of osteoporosis. This ruled out ossifying periostitis, and the diagnosis rested between osteomyelitis and sarcoma. In sarcoma, present so high in the femur, amputation as yet has not obtained a cure, and we must consider some form of sclerosing periostitis as a possibility. It would be wiser in this case to try X-ray therapy first and then cut down upon the tumor if necessary to settle the diagnosis.

X-ray treatment was given at intervals. Three months after treatment there was an area of breaking down, with pus formation, and a small piece of bone was removed. Six months after treatment the periosteal mass was distinctly smaller. The soft-part tumor partly disappeared. X-ray examination showed a healed process. X-ray find-



Fig. 5-B. Same case as shown in Figure 5-A. Roentgenogram made one month later, showing increased bone destruction.

ings of the lungs had been entirely negative throughout.

It is now over seven years since this patient entered the clinic and since his injury, and, as far as our examinations can tell, he is perfectly well.

The final diagnosis was osteomyelitis with ossifying periostitis.

Case 5.—The patient was a white male, aged 25, who had had osteomyelitis of the right tibia when he was 16 years of age, which apparently had healed completely. At the age of 23 a small sinus developed over the old scar. This drained for five or six months and then healed. Two months before entering the clinic he had pain over the right thigh following a long automobile drive and a game of golf. There had been slight fever for one month.

On examination of this leg no soft-part infiltration was found, but the scar was adherent to the muscle. Some thickening of the bone around the lower third of the femur was present. There was no evidence of any acute disease or of a neoplasm; however, the patient felt a little tenderness over the scar.

The X-ray films in this case, taken one month apart, showed an area of destruction in the region of the medullary canal about the junction of the middle and lower third of the right femur. Surrounding this area there was an irregular thickening and some new bone formation. It did not suggest a neoplasm but rather a subacute osteomyelitis. About two months later, following excessive exercise, it again became sore, but under rest returned to normal and no operation was necessary. The final diagnosis was subacute osteomyelitis. The patient has been well over two years.

Had the diagnosis of sarcoma been made the most radical amputation possible would have been necessary with such extensive in-

volvement of the bone and the lesion's position near the trochanter. This could not have offered more than a slight chance of a cure. The diagnosis of subacute osteomyelitis having been made in all cases, the summary of the treatment given is as follows:

Case 1.—Foci of infection removed or cleared up; removal of some sequestra, followed by proper rest and care. The patient has been well for two years.

Case 2.—Exploratory operation; removal of tissue for diagnosis, followed by proper hospital care. Patient lived for ten years.

Case 3.—Removal of sequestra and clearing up of foci of infection. Patient has been well for five years.

Case 4.—X-ray treatment; removal of sequestra. Patient has been well for seven years.

Case 5.—No operation; rest. The patient has been well for two years.

None of these cases had any radical operation performed, the main treatment being removal of any foci of infection present, followed by proper hygienic care.

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## LESIONS OF THE UPPER FEMUR

By GEORGE T THOMPSON, BALTIMORE, MARYLAND

From the Surgical Pathological Laboratory of the Johns Hopkins Hospital and University

**T**UMORS of bone of the upper femur present to the surgeon a problem which differs from that of lesions of bone elsewhere. The basis for this difference appears to be:

- (1) The greatly increased liability of the upper femur to become the site of tumor metastasis;
- (2) The inaccessibility of the upper femur, hiding all but large, advanced tumors unless they be specially examined for;

- (3) The assumption that "sciatic" pains are physiologic;
- (4) The increased liability of bone cysts to form here.

In any lesion of bone an accurate diagno-

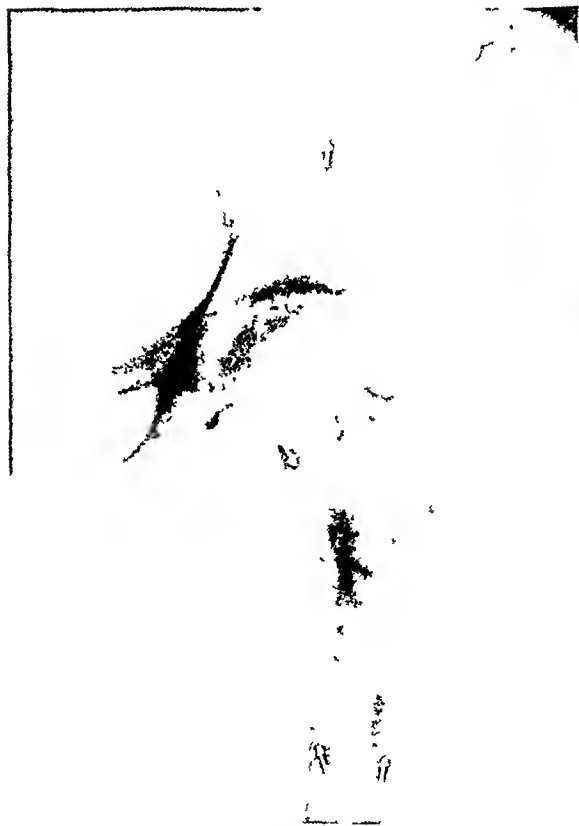


Fig 1 Metastatic carcinoma. A white female, aged 54, came to her physician fifty-seven months after a radical amputation of a breast, presenting the above X-ray film. There was a local recurrence in the breast scar eighty months following the primary operation, and death, one month subsequently. The X-ray film shows patchy bone destruction, expansion of the shaft, and some new bone formation. Path No 35,420



Fig 2 Bone cyst. The patient was a white female, aged 14, who presented a history of pain in her hip and knee of nine days' duration. Operation was advised to prevent further bending deformity. The X-ray film, taken at the time of the first visit, shows an expansive tumor occupying the greater trochanteric region, with moderate coxa vara and little bone formation. Trabeculation is evident. An X-ray film taken three years later showed increased expansion of the cyst. One year after the X-ray film reproduced above was taken, a pathologic fracture occurred. Path No 34,176

sis is of the first importance if the surgeon is to give the patient the benefit of an operation when operation is needed, or the benefit of more conservative treatment when such treatment is indicated. The difficulties involved are, first, a diagnosis, and second, the fitting of the treatment to the diagnosis. Both of these offer problems peculiar to the upper femur.

Malignant lesions of the upper femur are not peculiar in their variety, including multiple myeloma, metastatic carcinoma, and the varieties of sarcoma. The situation is, however, altered by the fact that just over one-half of the malignant lesions at this site are metastatic growths. Of 71 malignancies of the upper femur that are recorded in the Surgical Pathological Laboratory of the Johns Hopkins Hospital, 36 are metastatic growths from tumors elsewhere. This group of 36 cases is thus removed from the possibility of surgical cure. Palliative measures—X-ray, radium, and Coley's serum—are all that the surgeon can offer the patient afflicted with such bone involvement. In case of the other malignant lesions, here as elsewhere, early diagnosis is of prime importance. Advanced cases make surgery ineffectual because of distant metastasis, and even in relatively early cases there are local difficulties.

The common history of lesions of the upper femur is that the patient first experiences pain in and about the hip, and goes to his local physician or chiropractor, who treats him for "rheumatism" by massage, light, etc. He continues this for a time, and finally he goes to some one who has the possibility of a bone tumor in mind, palpates for it, and makes an X-ray film. But the delay in diagnosis has made the chance of cure a hope rather than a probability. Had the tumor been in any other of the long bones, as the ulna, the tibia, or the humerus, where a tumor would have been readily palpated, probably by the patient himself, or



Fig. 3. Ossifying periostitis. The patient was a white female, aged 30, who had had trouble with her hip for seven years. At its inception the condition had been diagnosed as osteomyelitis. In the X-ray film, taken seven years after the onset of her trouble, there are seen calcified nodules, distant from the main calcified mass, and extensive ossification, suggesting bone formation on the basis of an old osteomyelitic or psoas abscess. A recent X-ray film, taken seven years after the one shown herewith, depicts the condition to be practically unchanged. Path. No. 33,958.

where pain occasioned by the lesion would not have been labelled "sciatic" or "rheumatic" and considered as functional, discovery would in most instances have been much earlier and cure more likely. It is a significant fact that of the malignancies of the upper femur, recorded in the Surgical Pathological Laboratory of the Johns Hopkins Hospital, there are no five-year cures, whereas five-year cures of the sarcomas of the upper humerus, a more accessible bone, total four.

Of the benign lesions, less need be said. Their importance is largely a negative one—they must be recognized and differentiated from the malignant lesions. Nearly one-half are bone cysts. Symmetrical expansion of the bone shell, pathologic fracture, deformity due to long use of a weakened bone, age, and absence of symptoms make recognition without biopsy relatively easy. When

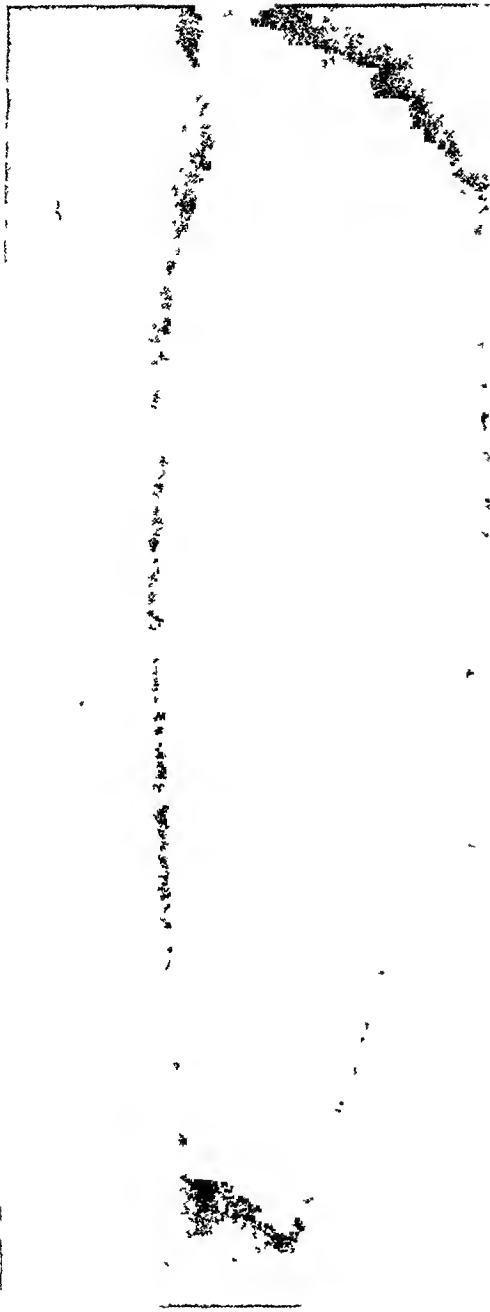


Fig 4 Ewing's sarcoma. A white female, aged 14, who gave a history of pain and swelling of eighteen months' duration. Three and a half months after an exploratory operation the patient died. The X-ray film shows typical, onion-peel stratification in the newly formed bone, symmetrical expansion of the shaft, and no encroachment upon the marrow cavity. Path No 15,745

fractured, they usually heal upon simple fixation.

Exostoses—usually discovered accidentally—are characterized by tumor only, with

limitation of movement if the site is such that mechanical interference is produced. X-ray films are diagnostic. The possibility of change into a secondary chondromyxosarcoma must be borne in mind.

Recognition of giant-cell tumors and their differentiation, as in bone cysts, are more difficult at the head of the femur. Here there are three different and separate epiphyses, one each for the head, the greater trochanter, and the lesser trochanter. Thus the rule that giant-cell tumors develop only in the epiphysis and bone cysts only in the shaft becomes of less help in differentiating tumors of this region. (It is true that the upper humerus has three epiphyses, but they fuse with one another early, and later unite with the shaft.) The age of the patient is of the greatest help. Giant-cell tumors generally occur in patients over twenty-five; bone cysts, generally in patients under eighteen. Differentiation from chondrosarcoma, which is of more importance, is more difficult. The protracted clinical course, and the deformity of bone produced by weight-bearing in giant-cell tumors and bone cysts have distinct diagnostic significance.

Myositis ossificans—not properly a lesion of bone—can be recognized in the X-ray film by the intervention of a layer of non-osseous tissue between the ossified tumor and the underlying bone. A history of trauma is obtained.

Ossifying periostitis offers the same diagnostic problem here as in the other long bones. We must exclude Ewing's tumor, periosteal sarcoma, and scurvy in extremely young patients. Certain diagnosis, without biopsy, is sometimes impossible. A Wassermann test will sometimes save operation. Needless surgery is to be avoided, but operation to determine the nature of the lesion, where radical treatment—if it is malignant—will offer hope of cure or the greatest prolongation of life, is the procedure of choice when other methods of diagnosis fail.

The following table shows the distribution of tumors of the upper femur, recorded in the Surgical Pathological Laboratory of the Johns Hopkins Hospital, compared to those of the upper humerus.

TABLE 1

|                            | Upper<br>femur | Upper<br>humerus |
|----------------------------|----------------|------------------|
| Ossifying periostitis..... | 5              | 6                |
| Myositis ossificans.....   | 3              | 1                |
| Exostoses .....            | 18             | 22               |
| Benign chondromas.....     | 1              | 2                |
| Bone cysts.....            | 45             | 32               |

TABLE 1 (continued)

|                                 | Upper<br>femur | Upper<br>humerus |
|---------------------------------|----------------|------------------|
| Giant-cell tumors.....          | 7              | 9                |
| Ewing's tumor.....              | 8              | 2                |
| Metastatic tumors.....          | 36             | 15               |
| Multiple myeloma.....           | 4              | 6                |
| Periosteal sarcoma.....         | 11             | 21               |
| Fibrosarcoma .....              | 2              | 1                |
| Osteolytic sarcoma.....         | 6              | 17               |
| <i>Total cases</i> .....        | 146            | 134              |
| Total malignant lesions.....    | 67             | 62               |
| Total benign lesions.....       | 79             | 72               |
| Percentage malignant.....       | 46             | 46               |
| Number of 5-year cures.....     | 0              | 4                |
| Percentage of 5-year cures..... | 0              | 6.4              |

# PATHOLOGIC FRACTURE

By E. DAVID WEINBERG, M.D., BALTIMORE, MARYLAND

From the Surgical Pathological Laboratory of the Johns Hopkins Hospital and University

**I**N a study of 1,700 bone tumors of all types, benign and malignant, there were found 160 pathologic fractures. The largest incidence, 62 per cent, occurred in multiple myeloma; 45 per cent were found in bone cysts, and in the group of metastatic carcinomas there were 33 per cent.

Naturally, we would expect the largest number of pathologic fractures to occur in the bone lesions which are characterized by bone destruction, with little or no bone production. This explains the high incidence in multiple myeloma and bone cysts. We find an exception, however, in giant-cell

TABLE I

| Types of tumors      | Percentage of pathologic fractures |
|----------------------|------------------------------------|
| Exostosis            | 1½%                                |
| Bone cyst            | 45%-50%                            |
| Giant-cell tumor     | 14%                                |
| Chondromyosarcoma    | 15%                                |
| Multiple myeloma     | 65%                                |
| Metastatic carcinoma | 33%                                |
| Sarcoma (osteolytic) | 35%                                |
| Sarcoma (periosteal) | 3.7%                               |

tumors, probably accounted for by their location near the epiphysis, whereas the other lesions occur as a rule in the shaft of the bone. We find a higher incidence of pathologic fractures in metastases from carcinoma of the breast as compared to metastases from carcinoma of the prostate. In the latter case, there is comparatively little bone destruction and more new bone formation, while in the former, there is a great deal of bone destruction with little or no new bone formation. In the periosteal type of sarcoma there is a diffuse or periosteal involvement at first. In this type, pathologic fracture occurred in only 3.7 per cent of the cases, whereas it was present in 35 per cent of the osteolytic type of sarcoma. Among the exostoses, we have seen no instance in which the fracture has occurred from the disease, although it is possible in cases in which there is a history of trauma sufficient to cause a fracture in a normal bone.

The rôle the pathologic fracture plays in the symptomatology varies with the type of tumor. In bone cysts, it is the symptom of onset in 38 out of 55 fractures. In only one instance in 15 fractures was it the factor which disclosed the underlying giant-cell tumor. Here, we usually get a history of pain, swelling, stiffness, and trauma before the fracture occurs. In none of the pri-



Fig. 1. Pathologic fracture through a benign bone cyst in the upper end of the femur. The femur is the bone most frequently the seat of pathologic fracture and the benign bone cyst is a tumor in which pathologic fracture most often marks the onset of clinical symptoms. This fracture healed spontaneously.

mary sarcomas or metastatic growths is the fracture the primary symptom. Geschickter and Copeland (1), in their extensive and able study of multiple myeloma, state that, "while a pathologic fracture is not infre-

commonly in the upper end of the femur, the upper end of the humerus, and the upper end of the tibia.

Ossification of these fractures in the different groups also shows a tremendous vari-



Fig 2 Pathologic fracture in a benign giant-cell tumor of the lower radius. The lower end of the radius is the most frequent site of this type of tumor. These fractures in giant-cell tumors do not heal unless the disease is treated.

quently the source of the first symptom of onset, it is less frequently recognized in itself as an initial sign of the disease."

Nearly every bone in the body has been the site of pathologic fracture. The femur is by far the most frequently involved, the humerus being next. Multiple myeloma is characterized by the fact that it usually involves the bones of the thorax—the ribs, sternum, vertebrae, and clavicles—whereas the other tumors seem to have a predilection for the long pipe bones. In multiple myeloma we also have instances of several pathologic fractures occurring in different bones at the same time. Bone cysts occur most

often in the upper end of the femur, the upper end of the humerus, and the upper end of the tibia. In bone cysts they always heal, and, if the fracture is extensive enough, it will also cause the cyst to ossify. In giant-cell tumors, we find that not one healed when the fracture occurred through the central part of the tumor. When the lesion perforates the bone shell there is evidence of ossification in the shell only. This tumor seems to destroy all osteoblastic power of the involved bone. In four of the cases of sarcoma in which there was a history of fracture, the fractures occurred in bones which, on X-ray examination, revealed no other abnormalities. The fractures healed, and, at a later date, sarcoma developed. In



one case, a fracture occurred in a bone which showed areas of osteoporosis. The fracture healed, but eleven months later a typical sarcoma developed. Therefore, while ossification may occur in this group,

by operation is necessary. In giant-cell tumors, we have four modes of attack: (a) irradiation; (b) curettement, with thermal cauterization; (c) resection; (d) amputation.



Fig. 3. Pathologic fracture in the upper humerus, which is the seat of an osteolytic sarcoma. Healing never takes place in this type of fracture, and the prognosis in this disease is extremely poor.

it is quite rare. In some of the cases of multiple myeloma, there are evidences of ossification within a normal period; in others, union is delayed, while some do not heal at all. In an atypical case reported by Geschickter (2), there was a pathologic fracture. It was splinted, and healed; some time after the splint had been removed, however, a refracture took place. This one also healed, with splinting.

The treatment of the fracture varies with the type of tumor in which it has occurred. In a bone cyst, we simply immobilize. If the fracture is not complete or if the cyst does not ossify, crushing of the bone shell

Treatment depends on the location and extent. Herendeen (3) claims that if X-ray dosage is not too strong, healing will occur. However, the treatment is prolonged, more uncertain, and without the advantage of biopsy. In malignant disease the treatment is rarely centered around the pathologic fracture, unless the fracture occurs during a course of irradiation, or subsequent to a local operation. In such instances, splinting and irradiation should be used in an attempt to restore the continuity.

The fracture, however, has a distinct place both in the diagnosis and the treatment of the malignant condition itself. In car-

tilaginous tumors involving the long bones, with medullary destruction, a pathologic fracture is usually an indication of some variant of chondrosarcoma. In other types of sarcoma as well as this type, the presence

no union occurs, cauterize the tumors with the thermal cautery, or curet and cauterize with zinc chloride. Treated otherwise, they will recur.

Geschickter (4) is of the opinion that



Fig. 4. Fracture in a case of multiple myeloma. In addition to the lesion in the humerus, smaller areas of involvement can be seen in the clavicle, ribs, and scapula. Multiple myeloma has the highest incidence of pathologic fracture of all bone tumors. In rare cases these fractures may heal, although the prognosis for the disease itself is hopeless.



Fig. 5. A case of metastatic carcinoma, with marked destruction and fracture of the femur. Healing of the fracture is very rare in cases of metastatic carcinoma to bone, and the outcome of the disease is practically always fatal.

of a fracture favors radical treatment, preferably amputation or radical resection, as it renders the limb useless.

In the bones of the hand and in those of the foot (with the exception of the os calcis), there are no malignant lesions among the entire 1,700 cases. The majority are chondromas and bone cysts, while a few are of the giant-cell type. One can, therefore, treat such fractures by immobilizing them to determine if they ossify. If

there is a histological and clinical paradox in chondromas or chondromyxoma. From his clinical experience, and from an intensive follow-up system, it seems that the chondromas of the bones of the hands and feet (with the exception of the os calcis) clinically are always benign. In the large bones, the long pipe bones, and the sternum they are always potentially malignant. Nevertheless, histologically, the sections of the tumors from the large bones nearly

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always appear benign, while sections taken from the same type of tumor in the carpal and tarsal bones practically always appear to be malignant.

with some destruction, it favors the diagnosis of a chondrosarcoma as against a benign chondroma.  
From the standpoint of treatment—

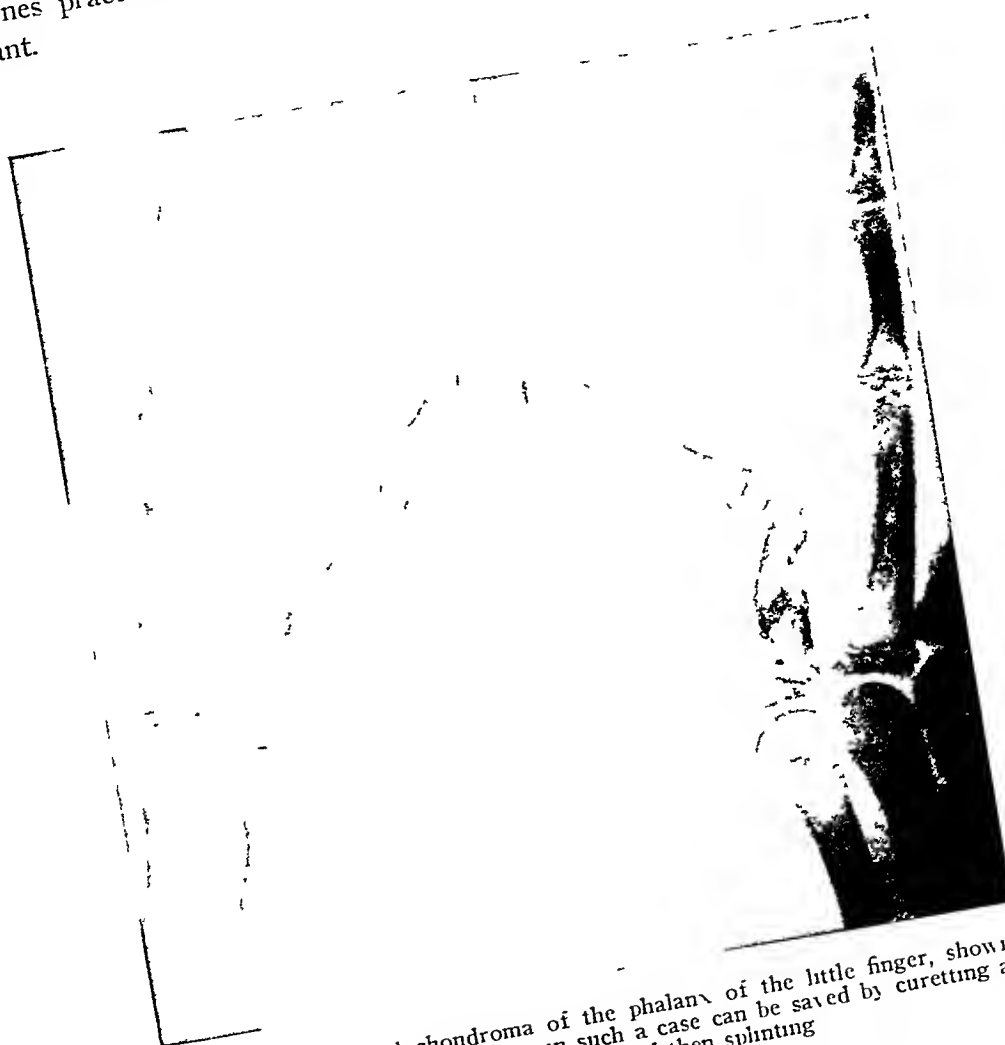


Fig 6 A central chondroma of the phalanx of the little finger, showing a pathologic fracture. The finger in such a case can be saved by curetting and cauterizing with 50 per cent zinc chloride and then splinting

## SUMMARY

From the standpoint of diagnosis, pathologic fracture is helpful—

- (1) As a symptom of onset in a central tumor of the shaft. In a patient from five to fifteen years of age, the lesion is, most likely, a bone cyst.
- (2) Occurring in a rib of an adult, it favors multiple myeloma.
- (3) If the lesion is a cartilaginous one in a long pipe bone, and there is a fracture

(1) A pathologic fracture is a good sign in a bone cyst, and it is to be treated as a simple fracture.

(2) Immobilize fractures in tumors of the bones of the hands and feet. If no ossification takes place, cauterize with the thermal cautery or curet and cauterize with zinc chloride.

(3) Occurring in multiple myeloma and giant-cell tumors, we are justified in splinting and using deep X-ray therapy, hoping to obtain healing in multiple myeloma, and a



Fig. 7. A case of periosteal osteogenic sarcoma of the pelvis, producing splintering and fracture of the ischium. This sarcoma was of the chondrosarcoma type and was secondary to an osteochondroma of the pelvis. This patient died in spite of deep X-ray therapy.

cure in giant-cell tumor, unless it is too far advanced.

(4) In sarcoma and metastatic carcinoma, a pathologic fracture in a long bone generally indicates radical treatment—either a resection or an amputation—because the limb will otherwise be useless and painful. Finally, by precautionary measures, such as crutches or splints, we can often prevent a pathologic fracture in a destructive lesion.

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# EDITORIAL

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## WORKING RULES FOR LESIONS OF THE BONE

As experience accumulates in the larger clinics where the diagnosis of bone lesions is a daily problem, it becomes increasingly evident that certain working rules can be formulated, which will simplify greatly the problem of diagnosis and facilitate accuracy in the procedures recommended at consultation. Too often when an important decision is to be made by the consultant, the initial steps taken in the case have been inadequate or ill advised and much valuable time is lost. For this reason an attempt has been made to set up the following working rules which are subject to revision in the light of subsequent experience.

### THE RULES OF PROCEDURE

1. Take X-ray films after every severe injury followed by pain on motion of the part, or when there is increasing tenderness, swelling, and pain over the bone. The films should be retaken if not clear, and views should be obtained in two different directions.

2. Take an X-ray film of the opposite side for comparison; early changes are otherwise indiscernible.

3. Multiple foci of pathology or diffuse lesions in bone or about a joint in the first

film taken demand a film of the entire pelvis (lumbar spine and upper femurs included) and chest (with upper arms included) to rule out multiple bone or joint involvement, which usually contra-indicates surgery, and narrows the possibilities for diagnosis. An examination of the urine for Bence-Jones bodies is also essential.

4. Take a complete history and do a thorough physical examination, with special emphasis on palpation and search for a primary focus of infection or cancer outside of bone. Strive to rule out acute osteomyelitis by history and examination, for in no other lesion of bone is a moderate degree of delay costly.

5. If acute osteomyelitis is ruled out, use the X-ray film for consultation when in doubt, before surgery. Surgery is rarely indicated in the multiple lesions and in the minority of single lesions. There is no harm in waiting for a confirming opinion.

6. While waiting, put the part at rest and give deep X-ray or radium therapy to determine radiosensitivity. Four out of eight types of solitary bone tumors are radiosensitive—this provides a therapeutic test.

7. Regardless of the diagnosis, do not operate without a Wassermann reaction report.

8. Before operating for a malignant lesion of bone take an X-ray of the chest to rule out metastases.

9. Pulmonary metastases in a film of the chest are not proved unless there is fluid in the chest, cachexia, or a recurrent tumor or metastatic gland elsewhere in the body. A chest film does not contra-indicate surgery, if signs of metastases are doubtful.

10. Do not explore a doubtful tumor unless adequate provision has been made for

the interpretation of the biopsy material and for a radical operation if indicated.

11. If a previous operation has been done make every attempt to secure sections or tissue for examination.

12. Always explore the tumor before amputating, complying first with Rule 10, using a tourniquet and preferably the cautery or electric needle.

#### RULES FOR DIAGNOSIS

1. Tumors of the small bones of the hands and feet (excluding the os calcis) are usually benign.

2. A central tumor of the sternum is a benign chondroma.

3. A central bone-destructive lesion in the epiphysis of the lower radius which expands the cortex is practically always a giant-cell tumor.

4. Diffuse bending or bowing of the bone is in favor of a benign lesion.

5. Multiple lesions in children and in adolescents up to twenty years of age are benign, excepting bone dissemination from malignancy in internal organs, and in late Ewing's tumor. Multiple lesions in adults are malignant, except Paget's osteitis deformans and osteomalacia, and distinctly joint lesions.

6. A protracted history in adults is in favor of a benign lesion, with the following outstanding exceptions:

(a) Secondary chondrosarcoma occurring in benign exostoses or chondroma.

(b) Secondary osteolytic sarcoma at the site of an old infection or trauma.

(c) Sarcoma arising in Paget's osteitis deformans.

(d) Sarcoma arising in recurrent myositis ossificans

7. Lesions characterized by periosteal bone formation in adults are usually benign, whereas in patients under twenty this usually indicates malignancy unless the bone formation surmounts a pedicle of r

8. Malignancy following upon a benign bone cyst or a benign giant-cell tumor has never been proved although a central chondroma resembling these lesions may undergo sarcomatous change.

9. In young patients under twenty, lesions which are predominantly osteolytic are usually benign, with the exception of osteolytic sarcoma; and lesions with bone formation within the cortical confines in the medullary spaces, also are usually benign, with the exception of early Ewing's tumor. Osteolytic sarcoma is indicated by a marked destruction of the cortex without expansion, and Ewing's tumor by being radiosensitive.

10. In patients over thirty (adults) bone-destructive lesions that escape beyond the cortex are usually malignant unless occurring in an epiphysis (giant-cell tumor), in the small bones of the hand or foot (chondroma), or at a joint (tuberculosis). Periosteal bone formation predominating in adults is usually benign. Distinctly periosteal bone formation in young patients, unless surmounting a pedicle of normal bone, is usually malignant.

#### RULES FOR TREATMENT

1. Where the Wassermann reaction is positive, a course of antisyphilitic treatment is essential before instituting surgery.

2. Deep X-ray therapy should be discontinued in favor of surgery if definite results are not obtained in six weeks.

3. A sarcoma at the upper end of the femur has never been cured by amputation.

4. In the bones of the arm and the fibula, a radical resection offers as much for the cure of malignant disease as does amputation.

5. Unless multiple bone involvement is inflammatory beyond exception, surgery is contra-indicated.

6. The following tumors of bone are rare: (a) ... ; (b)

chondral forms of osteogenic sarcoma; control pain in bone disease temporarily except in cases in which there is an acute infection.  
(c) highly cellular forms of fibrosarcoma;  
(d) giant-cell tumor and giant-cell variants of bone cysts.

7. Pain is relieved and life lengthened by irradiation in metastatic carcinoma.

8. Deep X-ray therapy may be used to

9. Pathologic fractures may heal in any form of bone disease and never in themselves constitute a cause for amputation.

CHARLES F. GESCHICKTER, M.D.

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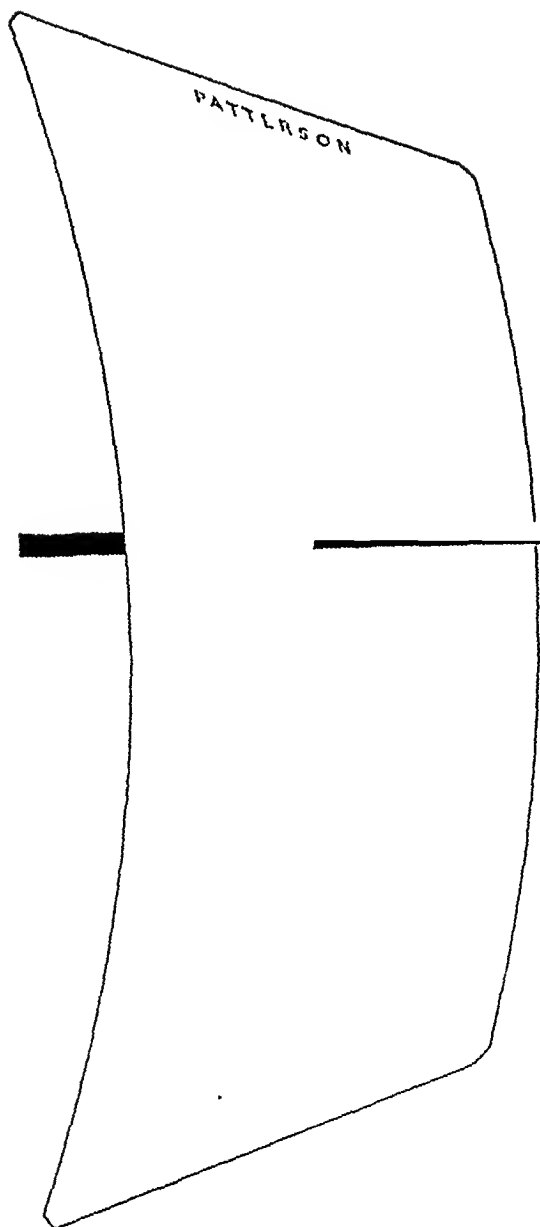
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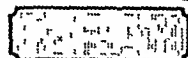
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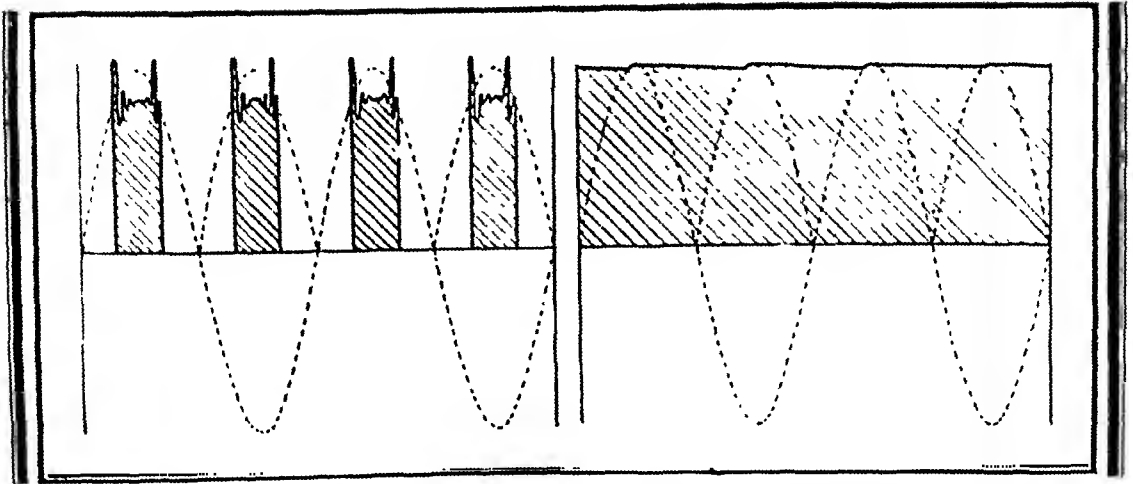
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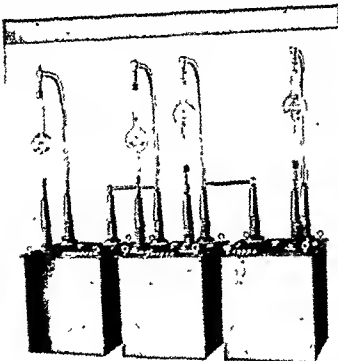
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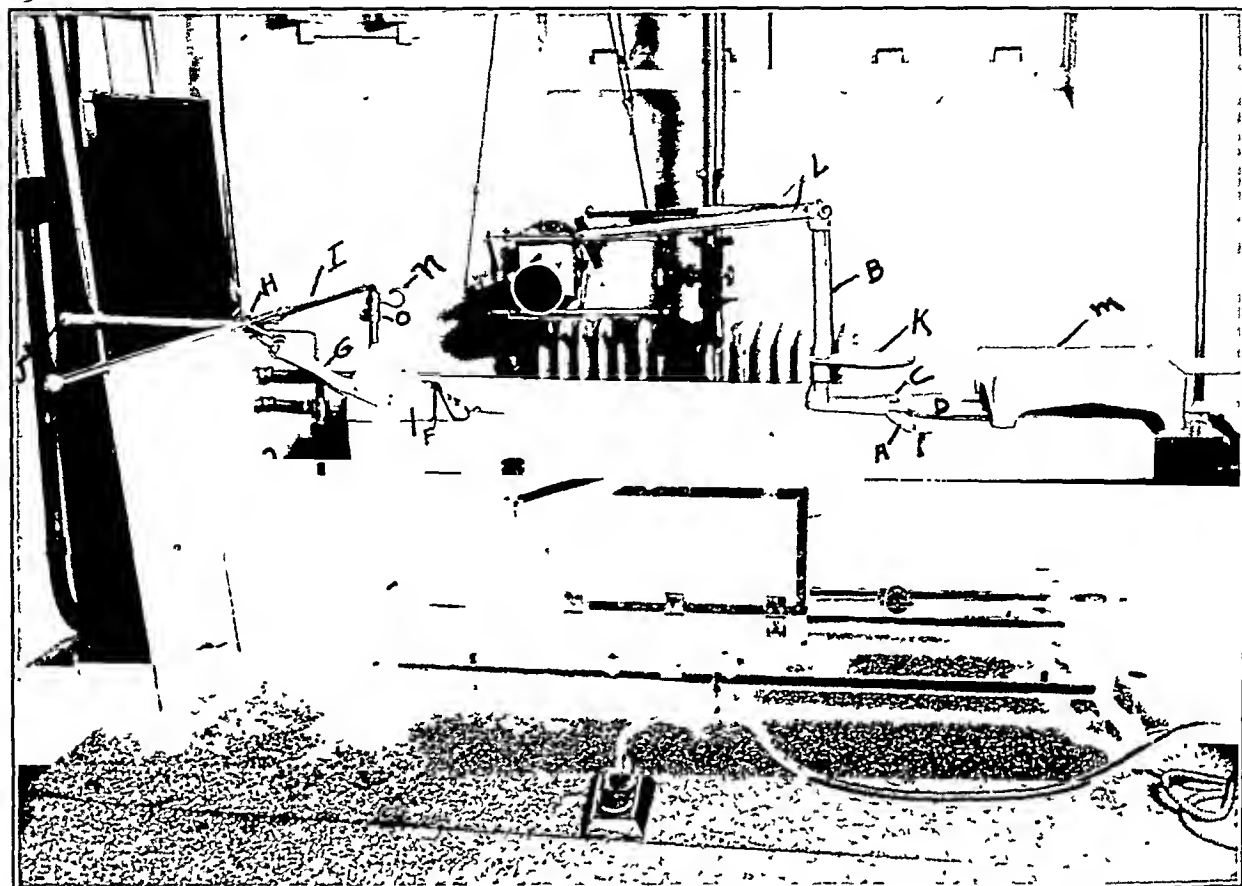


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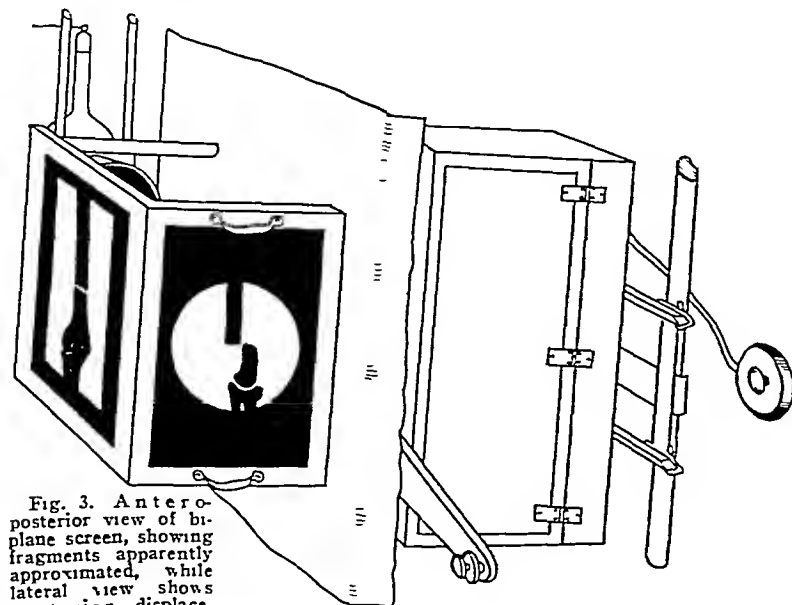


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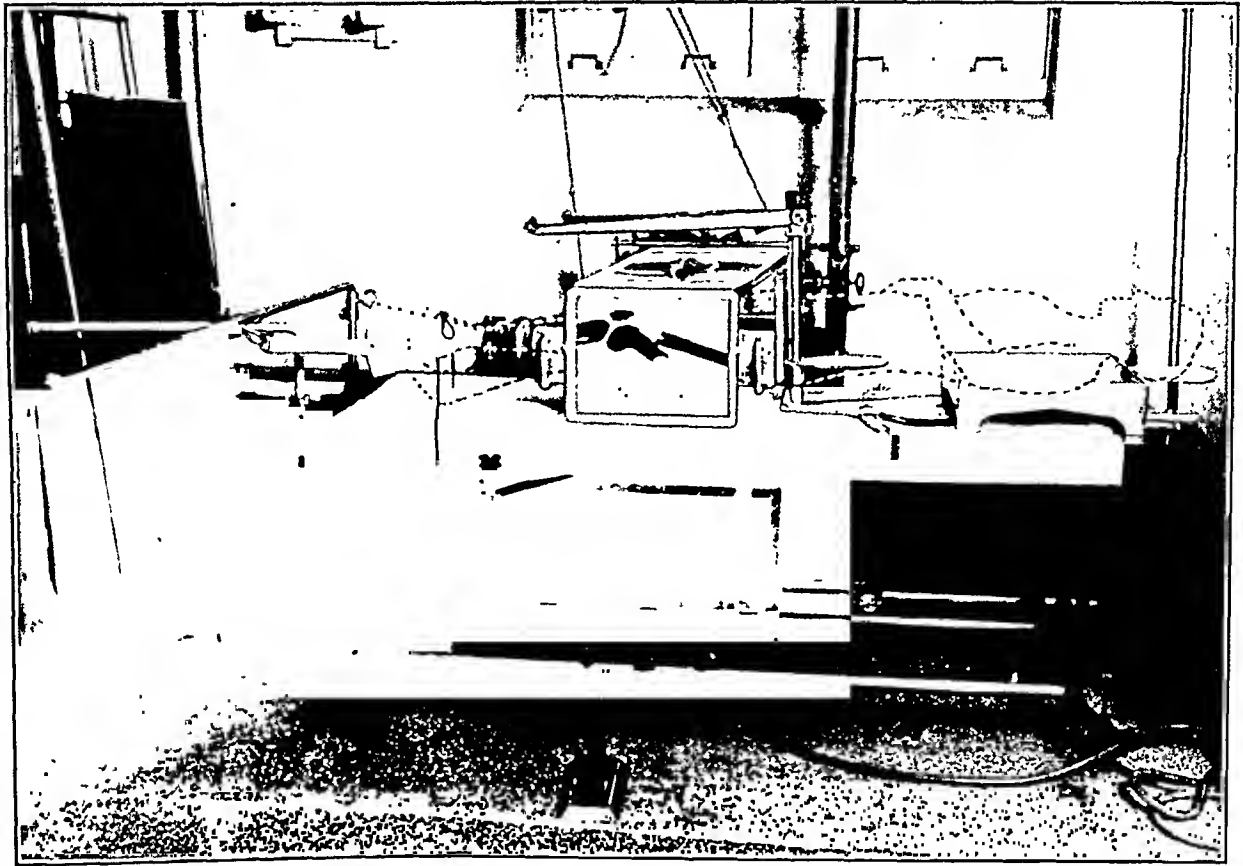


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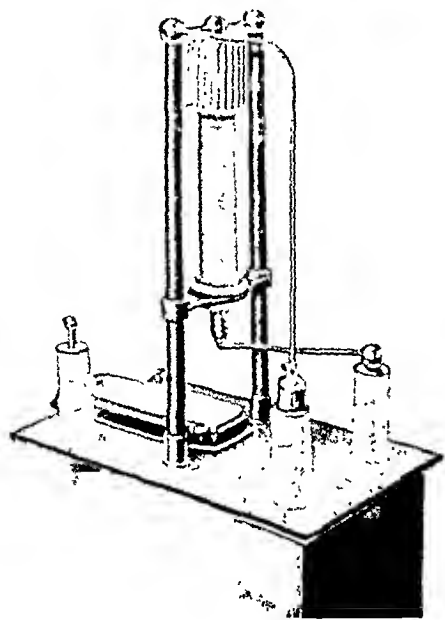
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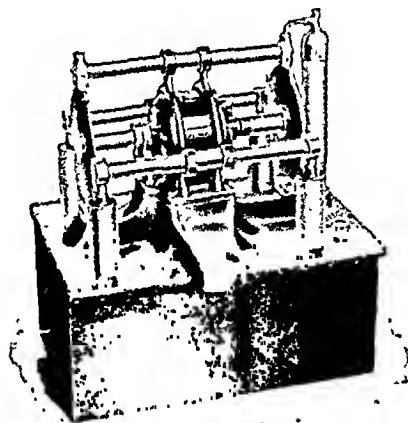
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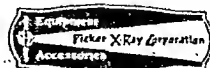
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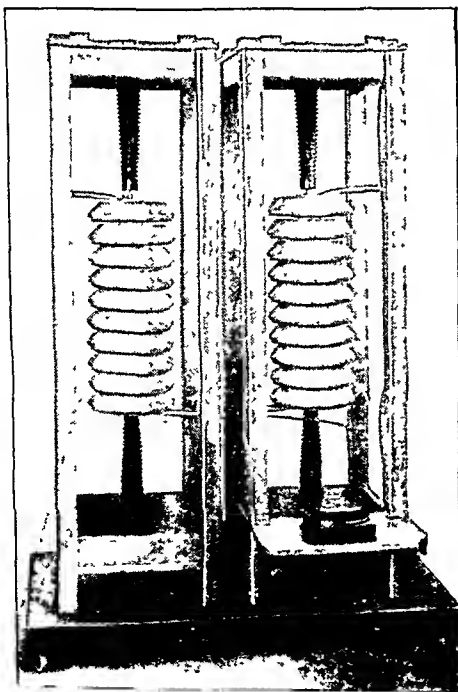
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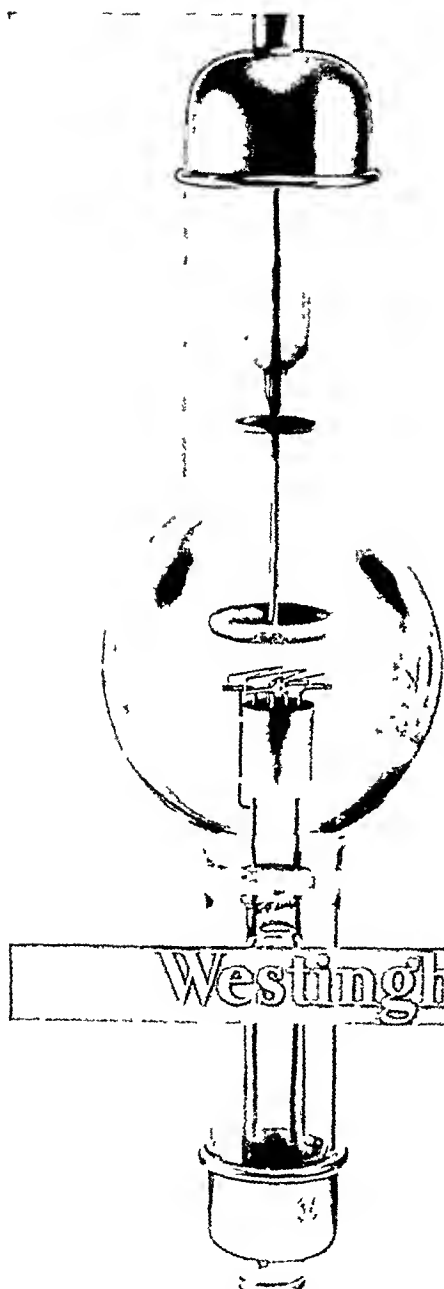
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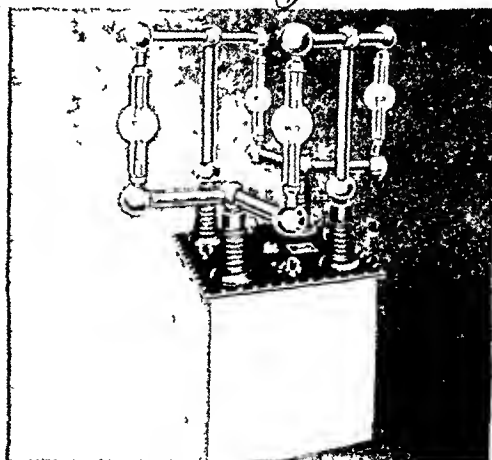
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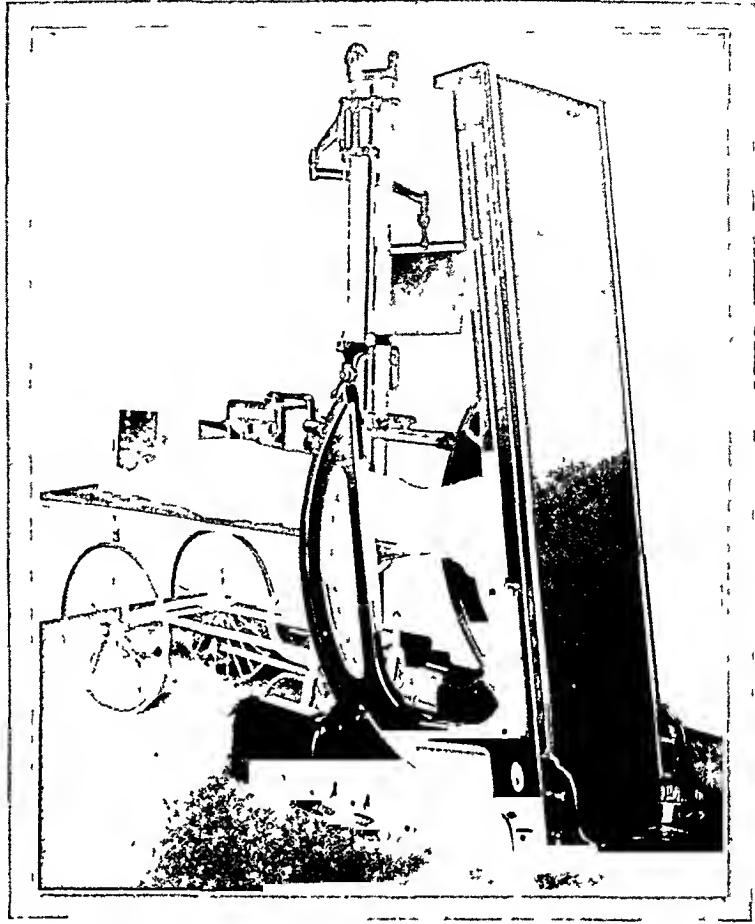


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PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

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No. 1

## RECENT PROGRESS IN X-RAY STANDARDIZATION<sup>1</sup>

By LAURISTON S. TAYLOR, Bureau of Standards, WASHINGTON, D. C.

*Abstract.*—Advances made in the measurement of X-ray quantity or intensity during the last three years are reviewed. A comparison of the cylindrical and parallel-plate types of air ionization chamber indicates that the latter is better suited for accurately determining the roentgen. The smaller guarded field parallel-plate ionization chamber is free of all the defects of both larger types of chamber. Preference is given to the null electrostatic current measuring system when covering a wide

range of sensitivities and to eliminate field distortion. For routine and secondary standardization measurements the current compensation scheme, using the radium ionization chamber, is more satisfactory. A comparison of various diaphragm systems indicates the necessity of a diaphragm close to the tube to eliminate off-focus and stem radiation. For quality measurements the effective wave length method, using thin (0.25 mm.) copper absorption screens, is recommended.

### I. INTRODUCTION

AT the Second International Congress of Radiology, held in Stockholm in July, 1928, the Committee on the Standardization of X-ray Measurements tentatively adopted as the unit of X-ray quantity the ionization produced by X-rays in air under standard conditions.<sup>2</sup> The recommendations of the Committee are:

"1. That an International Unit of X-radiation be adopted.

"2. That this International Unit be the quantity of X-radiation which, when the secondary electrons are fully utilized and the wall effect of the chamber is avoided, produces in one cubic centimeter of atmospheric air at 0° C. and 76 cm. mercury pressure, such a degree of conductivity that one electrostatic unit of charge is measured at saturation current.

"3. That the International Unit of X-radiation be called the 'roentgen' and that it be designated by the letter small 'r'.

"4. That various standard methods be employed to establish the unit.

"5. That for all comparative purposes it is advisable to employ ionization chambers which have been calibrated in terms of a standard chamber for X-radiation of the various qualities employed. It is also advisable to make the wall effects of these chambers as small as possible.

"6. That the practical instrument used to measure X-ray output be called a dosage meter (*Dosismesser*, *dosimètre*).

"7. That the constancy of the indications of the dosage meter be tested by means of gamma radiation emitted from a definite quantity of radium element, the measurement being carried out always under the same conditions.

"8. That any specification of dosage is incomplete without specifying the quality as well as the quantity of the radiation. The quality of X-radiation used for practical purposes is very varied and it would be impracticable to give a complete specification of it; but much information can be obtained from a knowledge

<sup>1</sup>Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce.

<sup>2</sup>RADIOLOGY, October, 1929, XIII, 372.

of the degree of absorption of the radiation in standard materials, the peak voltage applied to the tube, together with the filter employed, and the general character of the high tension apparatus.

"For practical purposes the quality may be expressed by stating the half value layer in a suitable material, or by stating the effective wave length as determined by the percentage amount of radiation transmitted through a given thickness of a suitable material (copper or aluminum).

"In view of the fact that rapid progress is being made in methods of X-ray measurement and in our knowledge of X-ray phenomena the Committee feels that the above recommendations should be regarded as being of a provisional character."

It was recognized at the time that our knowledge of the use of a standard air ionization chamber had not yet reached an entirely satisfactory state, consequently no definite stipulations were made regarding details required in the determination of the roentgen (r). Since this last Congress, however, various workers have carried out independent investigations, with the result that many questions which were previously uncertain now appear to be satisfactorily solved. It seems opportune, therefore, to summarize and compare, where possible, the results of the various investigations, showing how they may be incorporated into an apparently satisfactory system for an unambiguous determination of the international roentgen.

As opposed to the types mentioned, Solomon<sup>3</sup> still advocates the use of a thimble chamber, standardized with the gamma rays of radium, as a primary standard. He stipulates, however, that the thimble chamber measurements be independent of the wave length of the radiation—a requirement which defeats its purpose when considering a choice between the thimble chamber and the free air ionization chamber, for only by

comparison of the former against the latter can assurance of such an independence of wave length be obtained.

As the principal basis of his continued advocacy of the thimble chamber standard, Solomon refers to a statement by Failla at Stockholm,<sup>4</sup> that free air ionization chambers give results which differ by as much as 300 per cent. However, this appears to be a misunderstanding on Solomon's part of Failla's results. The difference obtained by Failla referred to measurements with a correctly designed chamber and diaphragm system on the one hand and a given, obviously incorrectly designed chamber and diaphragm system on the other. Contrary to Solomon's contention, Failla's results indicate that, with proper design, a free air chamber should yield a very accurate measurement of the roentgen.

Another type of primary standard is being investigated by Rajewsky.<sup>5</sup> This is a spherical thimble chamber, but its primary calibration against Ra gamma radiation is so devised as to be independent of the distance between the Ra source and the chamber. If this can be accomplished simply and unambiguously, there may be many factors favoring its use.

The inherent difficulty with Solomon's method lies in the comparatively large number of geometrical requirements involved in the radium calibration,<sup>6</sup> a very small error in any of which will cause a relatively large error in the final result. Behnken,<sup>7</sup> Glasser<sup>8</sup> and others have evaluated Solomon's unit in terms of the roentgen and their publications show clearly the difficulties involved. Rajewsky's method, if successful, would avoid most of these.

<sup>4</sup>G. Failla. Paper read at Second Internat. Cong. Rad., July, 1928. See *Am. Jour. Roentgenol. and Rad. Ther.*, January, 1929, XXI, 47.

<sup>5</sup>B. Rajewsky, *Strahlentherapie*, 1928, XXX, 555.

<sup>6</sup>I. Solomon, *Jour. de Rad. et d'Elec.*, 1924, VIII, 851; 1926, p. 155; 1927, XI, 286.

<sup>7</sup>H. Behnken, *Strahlentherapie*, 1928, XXIX, 192.

<sup>8</sup>O. Glasser, *Jour. de Rad. et d'Elec.*, 1928, XII, 421.

<sup>3</sup>I. Solomon, *Bull. et Mém. de la Soc. Rad. Méd. de France*, 1929, XVII, 45.

## II. THE FREE AIR IONIZATION CHAMBER

### 1. Cylindrical type of chamber

At present two principal types of free air ionization chamber are in general use—the cylindrical form used by Behnken<sup>9</sup> and the parallel-plate form used in France (by Dauvillier),<sup>10</sup> England, and this country. Until 1928 Behnken used a cylindrical pressure air chamber but has since changed to the simpler atmospheric pressure chamber commonly used elsewhere.

Behnken<sup>11, 12</sup> has published extensive studies of the pressure chamber characteristics; but, until the very recent work by Schlechtman<sup>13</sup> in Moscow, there has been no complete and critical study of the atmospheric pressure form of cylindrical air chamber. From Schlechtman's work we are led to believe that the performance of such a chamber is not quite as simple as heretofore assumed.

He finds that, to secure a proper electrostatic field within the chamber, the chamber ends must be fixed at an empirically determined potential somewhat lower than the saturation potential. He also finds that the saturation potential depends upon the area of the beam entering the chamber, although he again avoids any consequent difficulty by applying a potential to the ends. This can probably be accounted for by the fact that in a cylindrical chamber the potential gradient increases from the outer to the inner electrode. If the potential be adjusted for saturation with an entering beam of small divergence, there is no assurance that there will be saturation for the same beam if very divergent, because different portions traverse different fields.

Moreover, if in such a chamber the outer

ends of the guard electrodes extend very close to the chamber end (which is maintained at the saturation voltage), large field distortion results between the guard and the end. To avoid the effect, at the chamber center, of such distortion, the guards must be very much longer than in the case where they terminate at a distance from the chamber ends equal to the separation between the collector and the surrounding cylinder.

The Küstner<sup>14</sup> cylindrical chamber is not suited to absolute measurements of the roentgen because its construction does not avoid field distortion. It is, however, well suited for comparative purposes, as used, for example, in Schlechtman's work.

### 2. Parallel-plate type of chamber

In the parallel-plate ionization chamber some of the difficulties encountered with the cylindrical chamber are avoided, provided certain well-established geometrical factors are taken into consideration.

Various investigators have determined empirically that, for a *very narrow beam* of radiation, a plate spacing of about 10 cm is sufficient to insure complete utilization of the photo-electrons ejected by 200 kilovolt X-rays, although theoretically the range of such photo-electrons in air is several times this spacing. However, the path of a photo-electron is very crooked, so that the probability of one striking the plate 5 cm. away is exceedingly small, as first shown by Holthusen.<sup>15</sup>

The fact that the distribution of photo-electrons is different in the forward and backward direction, does not affect the effective volume of air ionized, provided the quality of the radiation does not vary appreciably over the length of the collector

<sup>9</sup>H Behnken, *Strahlentherapie*, 1928, XXVI, 79

<sup>10</sup>A Dauvillier, *Bull et Mem de la Soc Rad Méd de France*, 1929, XVII, 148

<sup>11</sup>H Behnken, *Ztschr. f Tech Phys*, 1924, V, 3

<sup>12</sup>H Behnken and R Jaeger, *Ztschr f Tech Phys*, 1926, VII, 563

<sup>13</sup>J Schlechtman, *Ann der Physik*, 1930, V, 153

<sup>14</sup>H Kustner, *Strahlentherapie*, 1928, XXVII, 231.

<sup>15</sup>H Holthusen, *Fortschr a d Geb d Rontgenstr*, 1919, XXVI, 211

electrode. It is possible that in a very long chamber, such as used by Chamberlain and Newell,<sup>16</sup> this may introduce a very small error.

The first practical form of parallel-plate chamber was constructed by Duane.<sup>17</sup> It was subject to error from two principal causes—field distortion at the diaphragm end and insufficient plate spacing for high voltage radiation. Duane and Lorenz<sup>18</sup> have since modified the chamber to eliminate these errors. To avoid field distortion at the collector, they find that the lead diaphragm for restricting the beam must be kept at the right potential. Their use of a galvanometer to measure the ionization current requires a relatively large diaphragm area. Taylor<sup>19</sup> has shown that this may introduce an error in the effective air volume unless the chamber is placed sufficiently far from the X-ray tube. They also use their chamber without any surrounding case for electrostatic shielding, which is practicable only under exceptional laboratory conditions. There appears to be no apparent reason, however, why such shielding should not be used if circumstances demand.

Glasser and Portmann<sup>20</sup> in their original form of standard chamber did not allow sufficient spacing between the electrodes and the surrounding box, although the probable field distortion was not large. An indirect check between their standard and the Bureau of Standards<sup>21</sup> chamber showed a difference of about 3 per cent which, under the circumstances, may be considered quite satisfactory.

Failla<sup>22</sup> has reported one of the most com-

plete studies of the design of the standard chamber and his results have been checked in detail independently by the less elaborate studies of Taylor,<sup>23</sup> which were conducted at about the same time.

The latter found that the guard plate width should be at least 1.5 times the spacing between the high potential and grounded plates. If Failla's data on the distribution of uniform electrostatic field between the chamber electrodes for a fixed chamber length be plotted, his results may be compared with Taylor's. The resulting curve (Fig. 1) gives the maximum width of uniform field as a function of the plate spacing for a fixed overall plate length of 42 centimeters. To apply Failla's results we may take, as an example, a plate spacing of 10 cm. (A on the curve), for which we find a central uniform field 12 cm. wide, leaving 30 cm. for the two guard plates (15 cm. wide, each), which is exactly 1.5 times the plate separation. This shows perfect agreement between Failla's and Taylor's criteria.

By further application of Failla's curve to Glasser and Portmann's chamber, we find for their chamber length of 26.98 cm., a 10 cm. plate separation and a 5 cm. (approximately) collector width, only about 11 cm. remaining for the width of each guard plate. Failla's results indicate that 15 cm. is the minimum permissible width; we should, therefore, expect a small amount of field distortion in Glasser and Portmann's chamber.

Dauvillier<sup>24</sup> has also adopted a parallel-plate chamber, but his studies of the design have brought out no new features.

More recently Kaye and Binks<sup>25</sup> have described a standard chamber similar to the older Duane type,<sup>26</sup> designed, however, only for radiation up to 100 kilovolts. Conse-

<sup>16</sup>W. E. Chamberlain and R. R. Newell, *Am. Jour. Roentgenol. and Rad. Ther.*, December, 1924, XII, 509.

<sup>17</sup>W. Duane, *Am. Jour. Roentgenol.*, 1922, IX, 467.

<sup>18</sup>W. Duane and E. Lorenz, *Am. Jour. Roentgenol. and Rad. Ther.*, 1928, XIX, 461.

<sup>19</sup>L. S. Taylor, *Bureau of Standards Jour. Research*, 1929, III (R. P. 169), 807; *RADIOLOGY*, July, 1930, XV, 49.

<sup>20</sup>O. Glasser and U. V. Portmann, *Am. Jour. Roentgenol. and Rad. Ther.*, 1928, XIX, 47.

<sup>21</sup>A report of this work will be published in *Bureau of Standards Jour. Research* in conjunction with future calibrations of dosage meters.

<sup>22</sup>G. Failla, *Am. Jour. Roentgenol. and Rad. Ther.*, January, 1929, XXI, 47.

<sup>23</sup>L. S. Taylor, *Bureau of Standards Jour. Research*, 1929, II (R. P. 56), 771.

<sup>24</sup>A. Dauvillier. See Footnote 10.

<sup>25</sup>G. W. C. Kaye and W. Binks, *Brit. Jour. Radiol.*, 1929, II, 553.

<sup>26</sup>W. Duane, *Am. Jour. Roentgenol.*, 1922, IX, 467.

quently their plate separation of only 5 cm. may be sufficient as indicated by their measurements. However, they assume that the range of 100 kilovolt photo-electrons in air is only 1.5 cm., which is not in good agree-

is surrounded by a guard plate on all sides. Likewise, Kaye and Binks have employed such a guard system. Measurements made by Taylor have indicated that there is no necessity for such a construction, provided

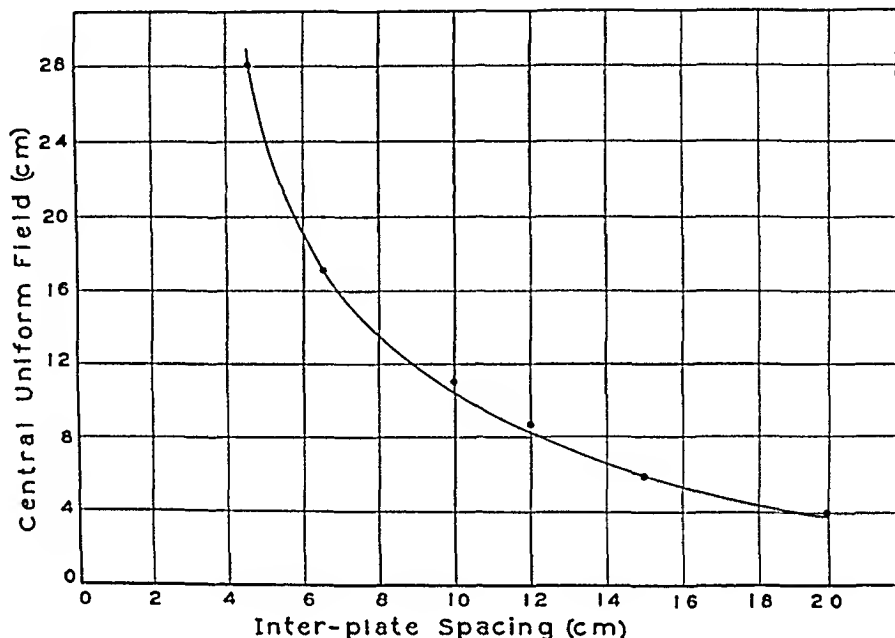


Fig. 1. Curve from Failla's data giving the width of uniform central field in a parallel plate ionization chamber as a function of the plate separation (overall plate length parallel to beam is 42 centimeters).

ment with C. T. R. Wilson's<sup>27</sup> results, which give a 1 cm. range to a 21 kilovolt electron in moist air. It may be that their electrometer system was not sufficiently sensitive to measure the small percentage of photo-electrons which reached the collector plate.

Applying Failla's conclusions to Kaye and Binks' guard plates, we find that they are only about two-thirds the necessary minimum width, so that some field distortion may be expected. Moreover, it is found that their plate system is too close to the grounded case, as indicated by Taylor's results as well as Failla's.

In the chambers used by Duane, and Duane and Lorenz,<sup>28</sup> the collector electrode

the guards and collector are sufficiently long (in a direction perpendicular to the beam), whereas such an arrangement presents greater difficulties in construction and proper insulation than does the plate system used by Glasser, Failla, Taylor and others. The presence or lack of a completely surrounding guard has no effect on the ionization measurements.

The large parallel-plate chamber designed by Taylor<sup>29</sup> fulfills all the criteria given by Failla. For a plate spacing of 10-12 cm., the guard plate width is 20 cm., thus allowing an appreciable safety factor over the width obtained from Failla's curve. In addition, the plate system is spaced from the

<sup>27</sup>C. T. R. Wilson, Proc. Roy. Soc., 1923, CIV, 1.  
<sup>28</sup>See Footnotes 17 and 18.

<sup>29</sup>L. S. Taylor, Bureau of Standards Jour. Research, 1929, II (R. P. 56), 771; RADIOLOGY, April, 1930, XIV, 372.

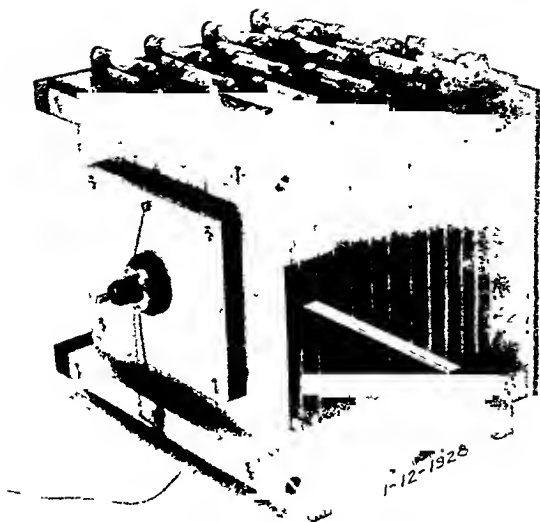


Fig. 2. Guarded field electrodes for standard ionization chamber of Taylor and Singer.

box by a distance equal to the plate separation, thus minimizing field distortion at the plate ends. This likewise eliminates the effect reported by Duane and Lorenz,<sup>30</sup> which requires that the entrant diaphragm be maintained at high potential. Failla<sup>31</sup> also found that suitable spacing from the box eliminated this effect.

This chamber is found to have none of the inherent defects discussed thus far. The complete chamber is consequently very large, and, with its surrounding shield of  $\frac{1}{8}$  inch lead, is very heavy. It is believed, however, that a precise determination of  $r$  will not permit of further reduction.

A much more convenient form of parallel-plate chamber has recently been described by Taylor and Singer.<sup>32</sup> In this, end field correction is provided by means of a system of guard wires extending all around the chamber in a series of planes parallel to the plate, as shown in Figures 2 and 3. Calculations by Snow<sup>33</sup> indicate that, with the

total potential across the chamber divided in equal steps on successive guard wires, the field 1 cm. inside the chamber should be uniform to within a very small percentage. As a consequence we are able by this arrangement to reduce the guard plates from a width of 20 cm. to 5 cm., and, likewise, the height of the plates from 25 cm. to 10 centimeters. Furthermore, since external field distortion cannot penetrate the guard wire system, the enclosing box need be spaced only 2 cm. from the plate system in any dimension.

By this method the difficulties noted above are entirely eliminated and the complete chamber is only about 16 cm. on a side as compared to  $40 \times 70$  cm. for the large chamber. A careful experimental comparison with the large chamber<sup>34</sup> shows agreement between the two within the limits of error of observation (about 0.4 per cent).

One of the outstanding advantages of this type of chamber is that it permits of the minimum distance between diaphragm and collector. This is particularly important if a single ionization chamber is to cover the wide range of X-ray qualities encountered in practice. A loss of intensity of several per cent has been found by Taylor to occur between the diaphragm and collector for some of the usual types of large air ionization chambers. In the guarded field chamber this distance is only about 10 cm., and consequently the effect of air absorption is minimized.

In addition, the collector plate is only 5 cm. wide, so that there will be a minimum change in X-ray quality, due to air absorption over its width. This also is essential in the computation of the effective volume of air ionized.

### 3. Material of standard chamber electrodes

Theoretically the plates of a chamber should be made of some material, such as

<sup>30</sup>W. Duane and E. Lorenz, *Am Jour Roentgenol and Rad. Ther.*, 1928, XIX, 461.

<sup>31</sup>G. Failla, *Am. Jour. Roentgenol and Rad. Ther.*, 1929, XXI, 47.

<sup>32</sup>L. S. Taylor and G. Singer, *Bureau of Standards Jour Research*, 1930, V (R. P. 211), 507. *RADIOLOGY*, December, 1930, XV, 637.

<sup>33</sup>C. Snow, *Bureau of Standards Jour Research*, 1928, 1 (R. P. 17), 513.

<sup>34</sup>L. S. Taylor and G. Singer. See Footnote 32.

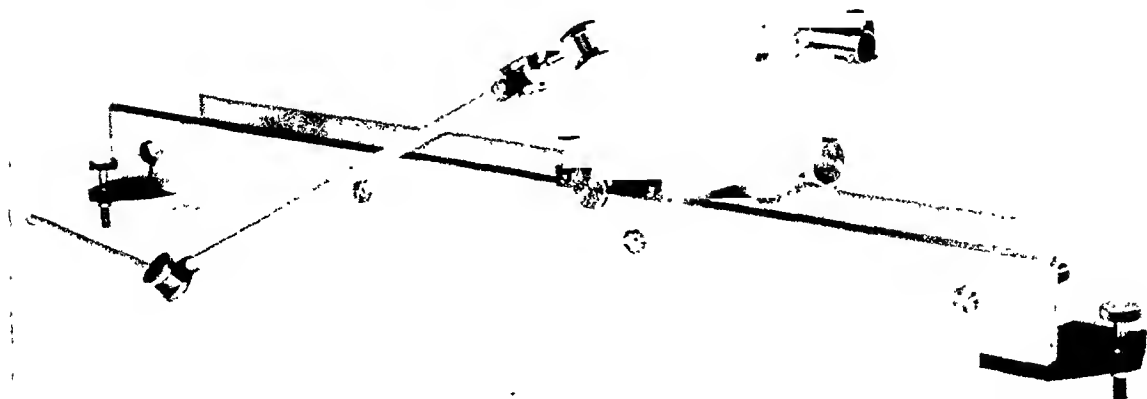


Fig. 3. Complete guarded field standard ionization chamber showing four-foot bench and electrometer leads.

suggested by Fricke and Glasser,<sup>35</sup> which has the same effective atomic number as air. This is based on the fact that, when X-rays scattered by air strike such a wall, photo-electrons of the same general velocity distribution will be ejected, thus producing the same ionization effect as if air actually replaced the plates.

It has been the practice of many observers to coat the electrode surfaces with a graphite paint or its equivalent. However, it is doubtful if such a procedure is of great advantage, since scattered radiation can penetrate such a thin layer and then eject photo-electrons from the plate, which is what we wish to avoid in the first place. Moreover, we cannot consider an "air wall" plate as truly the equivalent of air when used in such a manner, because by so doing we must neglect the photo-electrons which are ejected in a forward direction into the wall and are therefore lost as far as their ionizing is concerned.

Duane and Lorenz<sup>36</sup> have made measurements of the ionization in a chamber, the

plates of which were painted with a graphite mixture, and found a negligible difference as compared with the unpainted plates of aluminum, but a small difference between brass and aluminum electrodes. Behnken<sup>37</sup> uses a cylindrical chamber painted with graphite, and Kaye's chamber<sup>38</sup> is lined with 3 mm. graphite sheets. Measurements made by the author with a chamber having sheet graphite plates agreed within the limits of error with those of a chamber having aluminum plates.

Moreover, with a diaphragm system properly designed so as to prevent diaphragm scattering, a negligible amount of air-scattered radiation should be incident on the plates. To test this in the larger chamber used by Taylor, a photographic plate wrapped with lead wire was placed next to the collector plate for 15 minutes while an X-ray beam passed through the chamber. Not the slightest shadow of the wire was visible on the plate after development, thus bearing out the contention above.

It appears conclusive, therefore, that un-

<sup>35</sup>H. Fricke and O. Glasser, *Am. Jour. Roentgenol. and Rad. Ther.*, 1925, XIII, 462.

<sup>36</sup>W. Duane and E. Lorenz. See Footnote 18.

<sup>37</sup>H. Behnken, *Strahlentherapie*, 1928, XXVI, 79.

<sup>38</sup>G. W. C. Kaye and W. Binks. See Footnote 25.



painted aluminum is a satisfactory plate material for use in a standard chamber.

### III. METHODS FOR MEASURING IONIZATION CURRENT

In the early use of the free air ionization chamber most observers overlooked the importance of field distortion. We have seen in Section II how plate end distortion has been dealt with so as to insure a uniform field over the width of the collector electrode, but it was apparently not until the recent work of Failla<sup>39</sup> and Taylor<sup>40</sup> that the full importance of field distortion at the region between the guards and collector electrode was realized.

Current measuring methods involving the deflection electroscope invariably set up large disturbing potential differences between guard and collector; and, since the guard plate widths are usually so fixed as to just provide uniform field at the collector, a small disturbance, due to a potential difference between guard and collector, may upset the originally uniform field. The effect of such a disturbance has been investigated by Taylor<sup>41</sup> and found to be unduly large.

Glasser and Portmann,<sup>42</sup> and Behnken,<sup>43</sup> suspecting some such effect, allowed the electroscope to discharge between potentials equally above and below that of the guards, assuming that the field distortions would be equal and opposite in effect. Taylor has shown, however, that such an assumption is not justified, for the net distortion was sufficiently large to demand elimination. More recently Kaye and Binks<sup>44</sup> have investigated this effect, finding it negligible. They employed, however, a deflection method in this study, whereas Taylor used a null method

where all potentials remained constant, so the effect in their case may have been masked by the method of current measurement. On duplicating Glasser's conditions, as nearly as possible, Taylor found the effect to be quite pronounced. It would thus seem desirable to have Kaye and Binks' work repeated, using a null method.

Behnken's<sup>45</sup> later method of ionization current determination, by measuring the potential drop across a very high resistance ( $10^9$  ohms) with a quadrant electrometer, maintains the collector at essentially zero potential, hence should be quite satisfactory, provided the high resistance remains constant.

Duane<sup>46</sup> employs a d'Arsonval galvanometer of very high sensitivity to measure his ionization currents. This again is satisfactory except that the limited sensitivity of the galvanometer prevents measurements with sufficient accuracy of weak or very highly filtered radiation. It also necessitates the use of large diaphragms, which is satisfactory only if special precautions are taken.

To eliminate the difficulties mentioned, Failla<sup>47</sup> and Taylor<sup>48</sup> independently devised sensitive null indicating electrostatic measuring methods which each used successfully for over a year before publication. Most other investigators have since adopted some such method; Dauvillier<sup>49</sup> most recently has reported its successful use in connection with his chamber.

The methods of Taylor and Failla are the same in principle, the former using a variable potential for accomplishing compensation<sup>50</sup> while the latter uses a variable capacitance for compensation. With both of these methods the collector electrode is main-

<sup>39</sup>H. Behnken. See Footnote 9.

<sup>40</sup>W. Duane, *Am. Jour. Roentgenol.*, 1922, IX, 467.

<sup>41</sup>G. Failla. See Footnote 22.

<sup>42</sup>L. S. Taylor. See Footnote 23.

<sup>43</sup>A. Dauvillier. See Footnote 24.

<sup>50</sup>Compare D. L. Webster and A. E. Henning, *Phys. Rev.*, 1923, XXI, 301.

<sup>37</sup>G. Failla. See Footnote 22.

<sup>38</sup>L. S. Taylor. See Footnote 23.

<sup>39</sup>L. S. Taylor. See Footnote 23.

<sup>40</sup>O. Glasser and U. V. Portmann. See Footnote 20.

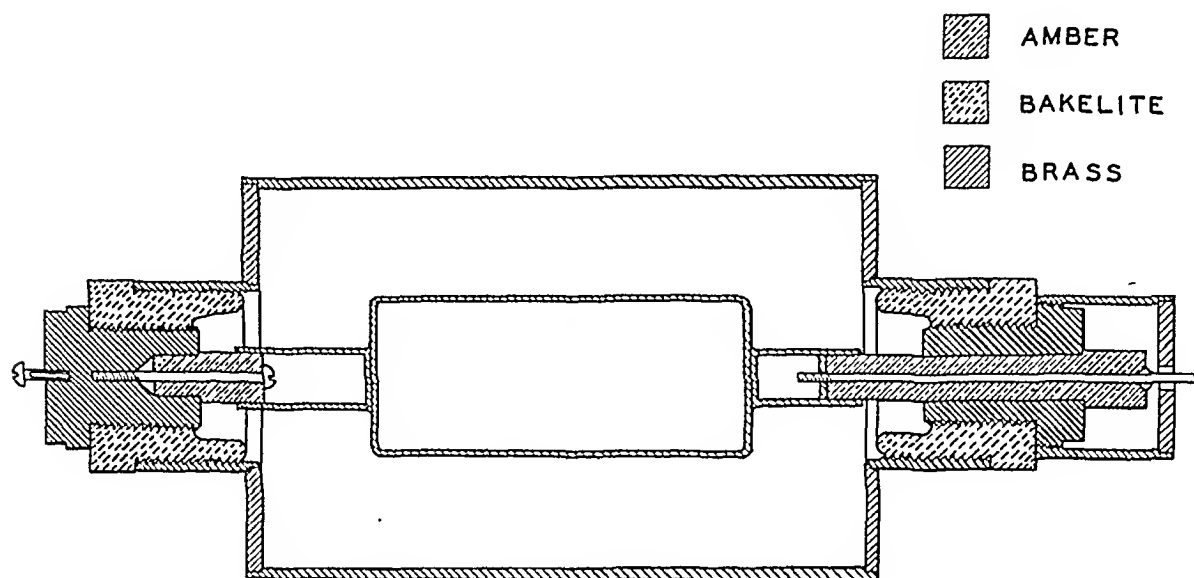
<sup>41</sup>H. Behnken. See Footnote 9.

<sup>42</sup>G. W. C. Kaye and W. Binks. See Footnote 25.

tained within a small fraction of a volt at the same potential (zero) as the guards, and, consequently, all guard-collector field distortion is effectively eliminated.

These methods have the advantage of a

Used in a null circuit, its zero current indications are independent of vacuum tube variations and consequent circuit instability, hence it should be highly satisfactory as an indicator.



### FAILLA RADIUM COMPENSATION CHAMBER

Fig. 4. Cross-section of Failla's radium compensator for null electrometer measurements. Inner cylinder is supported rigidly on amber, with a lead passing out to ionization chamber system. Outer cylinder coated on inside with radium preparation.

sensitivity range capable of measuring any ionization current encountered in practice. Another practical advantage is the fact that such a method is independent of variations in the electrometer sensitivity—a factor not easily controlled over a long period in the deflection methods.\*

Failla<sup>51</sup> has recently developed a d.c. vacuum tube amplifier circuit as a null current detector, which is more sensitive than the electrometer and, in most respects, more convenient to use, since the indicating instrument is an ordinary microammeter.

\*Note added in proof (Dec. 12, 1930): Since the preparation of this paper, the writer has devised a new method of calibrating and using null electrostatic circuits, which is 5–10 times more accurate than any heretofore used. This circuit is also designed to be independent of lead capacities and does not require insulation better than rubber. A complete description is being prepared.

Another new current compensation scheme has been recently described by Jaeger,<sup>52</sup> who employs a variable source of ionization current of known value to balance against the unknown X-ray ionization current. The equality of the two currents is indicated by a null reading string electrometer. His compensating current source is a saturated uranium oxide variable ionization chamber so constructed that the current is a linear function of the area of uranium oxide exposed.

Failla<sup>53</sup> has developed a different system of current compensation making use also of radio-active material. His source of variable current is a small cylindrical radium

<sup>52</sup>R. Jaeger, *Strahlentherapie*, 1929, XXXIII, 542.

<sup>53</sup>G. Failla. See Footnote 51.

<sup>51</sup>G. Failla, *RADIOLOGY*, October, 1930, XV, 437.

## IV. DIAPHRAGM SYSTEMS

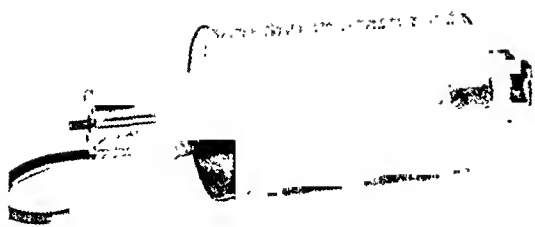


Fig. 5. Photograph of Failla's compensator assembled.

ionization chamber (Figs. 4 and 5), the ionization current in which is regulated by varying the applied voltage. The amount of radium in the chamber is so chosen that a range of a few volts will give currents covering the whole range encountered in practice. The chamber requires a high voltage for saturation, so that the working range lies at the foot of the saturation curve and gives practically a linear relation between voltage and current. This chamber has a distinct advantage over Jaeger's, being hermetically sealed and containing no moving parts the derangement of which would spoil the calibration.

Neither Jaeger's nor Failla's method has any outstanding merit as a primary source of current, as each must be calibrated by some null method as described above. However, the calibration is easy to make and control by means of a single voltage-current measurement for a high current value, by means of a galvanometer. As current-measuring methods of high precision and ease of manipulation they are very satisfactory and are to be particularly recommended for use with secondary standard chambers and clinical ionometers.

Until recently most observers have used a more or less arbitrary system of diaphragms for defining the effective area of the X-ray beam entering the standard chamber. It is believed that one of the greatest difficulties in bringing their standards into agreement has been due to this feature.

Behnken<sup>54</sup> was one of the first to show theoretically that the effective volume of air ionized in the free air chamber is given by the product of the area of the chamber diaphragm and the corrected length of the collector electrode. However, he made no extensive attempt to verify his results under widely differing experimental conditions. Many other investigators have likewise accepted them without further verification. Moreover, Behnken's analysis has been found to be correct within certain limiting conditions only.

Experimental studies by Taylor and Singer<sup>55</sup> have brought out the significant fact that, in designing a diaphragm system, we cannot leave out of consideration the fundamental purpose of the standard chamber—that of calibrating secondary chambers, including thimble chambers. They have found that diaphragming conditions must be adjusted to the needs of both types of chamber, which somewhat complicates the problem.

Failla<sup>56</sup> made the first fairly complete experimental study of the diaphragm systems and his final conclusions are rather broad. His method was to vary each of a number of factors, holding all others constant.

Taylor<sup>57</sup> developed first a simple geometrical analysis of diaphragm systems having what appeared to be reasonable restrictions and then conducted experimental studies

<sup>54</sup>H. Behnken, *Strahlentherapie*, 1927, XXVI, 79.

<sup>55</sup>L. S. Taylor and G. Singer, *Bureau of Standards Jour. Research*, 1929, III (R. P. 169), 807; *Radiology*, August, 1930, XV, 227.

<sup>56</sup>G. Failla. See Footnote 22.

<sup>57</sup>L. S. Taylor, *Bureau of Standards Jour. Research*, 1930, 111, 631; *Radiology*, July, 1930, XV, 49.

which bore out the validity of the restrictions. Later work by Taylor and Singer<sup>55</sup> took into consideration the calibration of a thimble chamber and the results indicated that the earlier restrictions were not only valid but necessary.

One of the principal points of contention between various observers has been the need for screening off target and stem radiation. Behnken<sup>56</sup> found that this was necessary for proper calibration of a thimble chamber. Failla's<sup>60</sup> results indicate that it is unnecessary and perhaps undesirable, but as yet he has not studied the calibration of a thimble chamber in an unrestricted beam. Glasser has changed his diaphragm system several times without reporting any analytical reasons therefor. We shall review a few of the factors which various studies have brought out.

Taylor<sup>61</sup> first only considered an X-ray beam in which target and stem radiation was completely shielded off. Assuming, then, the focus to be a point source of radiation, the range over which the inverse square law applied was calculated as a function of relative diaphragm distances and areas. An alternative assumption was that the focal spot emitted radiation uniformly (which is experimentally untrue), so that a diaphragm placed close to the X-ray tube should be of such size that the focal spot area filled the aperture of the cone determined by the tube diaphragm and the chamber diaphragm.

Experimental tests of these two assumptions indicated their validity under many different sets of geometrical conditions. The range over which the inverse square law held agreed closely with the predictions. Moreover, the experimental agreement with the second assumption was better than the first by a small factor but within experimental limits.

Failla<sup>62</sup> has given several sets of curves showing the relation between the ionization current and the area of a diaphragm 43 cm. from the tube when the chamber diaphragm was fixed at several different areas, each kept constant during a single run. Taylor obtained a similar curve and showed that the shape was due to the presence of off-focus radiation; the point where the curve flattens out occurs at the correct position on the basis of such considerations. A proposal by Duane was to make the diaphragm nearer the tube conform in area to the geometrical aperture of the chamber diaphragm and the focus, considered as a point. Failla found, however, that this arrangement did not permit the maximum ionization in the chamber—the explanation being that the focus cannot be considered a point and that the off-focus radiation is usually at least 10 per cent that of the focal radiation. His final conclusion is that the two diaphragms should be of about the same size, based on the fact that the ionization in the chamber is proportional to the area of the chamber diaphragm when the other diaphragm is large or absent. This has been checked also by Taylor. However, Taylor and Singer<sup>63</sup> find that this condition may be invalid when considering the correct calibration of a thimble chamber under such conditions.

The most fundamental requirement is that the beam be of uniform intensity over its cross-section within the area subtended by the chamber diaphragm or thimble chamber. Photometric measurements of the diaphragmed beam used in Taylor's<sup>64</sup> work indicate such required uniformity, whereas for a beam unrestricted by diaphragms the uniform area is usually insufficient to completely cover a thimble chamber. It was found, also, that visual alignment of the chamber and diaphragm is not always satis-

<sup>55</sup>L. S. Taylor and G. Singer. See Footnote 55.

<sup>56</sup>H. Behnken. See Footnote 9.

<sup>60</sup>G. Failla. See Footnote 22.

<sup>61</sup>L. S. Taylor. See Footnote 19.

<sup>62</sup>G. Failla. See Footnote 22.

<sup>63</sup>L. S. Taylor and G. Singer, Bureau of Standards Jour. Research, 1929, III, 807; RADIOLOGY, August, 1930, XV, 227.

<sup>64</sup>L. S. Taylor, Bureau of Standards Jour. Research, 1930, III (R. P. 119), 631; RADIOLOGY, July, 1930, XV, 49.

factory and should be checked by ionization measurements made by moving the chamber across the beam.

In addition it was found that, when the radiation is taken off the target at a small glancing angle as in Duane's system,<sup>65</sup> the beam intensity may vary appreciably over its width, thus prohibiting the use of wide diaphragms.

Taylor and Singer<sup>66</sup> have more recently reported a difference between the qualities of the radiation taken from the focus and the rest of the target. The presence of both of these radiation qualities will not affect the standard chamber measurements, whereas they do affect the thimble chamber readings. This is another reason for restricting the beam to the focal radiation alone.

On the basis of the reasons presented above, we may review what appear to be the requirements for a standard diaphragm system: (1) The X-ray beam should be so diaphragmed near the tube as to eliminate all stem and target radiation, at the same time providing uniform intensity distribution over the area of thimble chamber and standard chamber diaphragm. (2) The inverse square law for a small focus tube should apply to the distance between the focus and chamber or chamber diaphragm. (3) For a broader focus tube, the tube diaphragm area should not exceed such an aperture as determined by the focus and tube diaphragm, and that the inverse square law should be applied between tube diaphragm and the chamber diaphragm. (The last condition is the more accurate though not always practical.)

Except as mentioned, the calibration of a thimble chamber against a standard is not pertinent to the discussion at hand. This has been treated in some detail by Behnken<sup>67</sup> and in two papers by Taylor and Singer.<sup>68</sup>

The difficulties involved in such calibrations are well indicated by the recent work of Reisner and Neeff,<sup>69</sup> who reported supposedly large errors in calibrations made at the Physikalisch-Technischen Reichsanstalt. A later paper by Behnken and Jaeger<sup>70</sup> has pointed out the source of their error; and likewise an analysis, according to the discussion above, shows that their results are based largely on improper experimental conditions.

It may be noted that for the calibration of a secondary chamber such as Failla's "drum head" type, the X-ray beam entering the standard might have to be unduly large. This may be avoided by determining in advance the degree of uniformity of the beam over the area subtended by the "drum head" and correcting therefor.

## V. QUALITY MEASUREMENTS

### 1. *Energy distribution in the spectrum*

Measurements of the wave length energy distribution or quality of a beam of radiation have no direct effect on the measurements made with a standard chamber, since this is by definition independent of wave length. By being independent of wave length, we really mean, however, that the measured ionization depends upon wave length in exactly the same manner as does ionization in free air.

Quality measurement is important when calibrating the common form of thimble chamber, since, in general, the ionization they measure varies rapidly with wave length, particularly at lower voltages. We must, therefore, employ a uniform method for expressing this quality. In Germany the half value layer (H.V.L.) in copper or aluminum is extensively used. Since the H.V.L. depends also upon the wave form of the generating voltage we see that such

<sup>65</sup>W. Duane and E. Lorenz. See Footnote 19.  
<sup>66</sup>L. S. Taylor and G. Singer. Bureau of Standards Jour. Research. (in press).

<sup>67</sup>H. Behnken, *Strahlentherapie*, 1927, XXVI, 79.  
<sup>68</sup>L. S. Taylor and G. Singer. See Footnote 55.

<sup>69</sup>A. Reisner and T. C. Neeff, *Strahlentherapie*, 1929, XXXIV, 313.

<sup>70</sup>H. Behnken and R. Jaeger, *Strahlentherapie*, 1930, XXXVI, 778.

a method is in error if applied to different types of X-ray generators, as, for example, strictly constant potential (i.e., zero ripple) or sinusoidal half or full wave potential.

The effective wave length of general radiation, as proposed by Duane,<sup>71</sup> is not so open to this objection. Quimby<sup>72</sup> has reported a very careful study of the quality measurements made on the same beam of radiation by several different methods and finds that they all differ radically and not in an easily interpretable manner. This indicates clearly the necessity of a general agreement on the use of only one method of quality measurement. Many reasons may be put forward in favor of adopting the effective wave length method.

Since Duane's first proposal, Duane, Hudson, and Sterling<sup>73</sup> have proposed a slight variation in the method, so that we now find in common use the effective wave lengths obtained by the absorption in 1.0, 0.50, and 0.25 mm. of copper and 4.0 and 1.0 mm. of aluminum. Quimby pointed out that no two of these measurements could agree except for very hard radiation.

Later, Taylor<sup>74</sup> investigated quantitatively the differences involved between the several effective wave length methods and finds marked differences between values obtained with 1.0, 0.5, 0.25 mm. and very thin copper absorbers. His results check Quimby's<sup>75</sup> and, moreover, show that a very thin filter method is least ambiguous and should be used in the standardization laboratory. For practical purposes the 0.25 mm. absorber may be used except for radiation which is

lightly filtered, say for radiation having in excess of 0.3 mm. initial copper filtration.

Taylor's<sup>76</sup> results also showed that precise quality measurements cannot be made with a thimble chamber, although the lack of precision is not sufficient to prevent their use clinically. One precaution is always necessary in making quality measurements—the filter must be placed at least 10 to 15 cm. from the ionization chamber so as to prevent enhancement of the ionization due to scattered radiation.

## 2. Voltage measurements

Ordinarily voltage measurements are of secondary importance in X-ray measurements, provided the intensity and quality are accurately known. In the standardization laboratory, however, voltage measurements are important as checks on other measurements.

There has been much discussion recently of the validity of sphere-gap voltage measurements applied to constant or rippled voltage. Mutscheller<sup>77</sup> finds sphere-gap measurements 15 to 20 per cent too high as compared with the minimum wave length voltage obtained with a small Seemann spectrograph. Taylor<sup>78</sup> has recently constructed a 100-megohm voltage multiplier with which it is possible to measure high potentials with an accuracy of better than 0.1 per cent. Using such an instrument in parallel with a sphere gap on a high "ripple-voltage" generator (0.2 per cent ripple), he finds that the sphere gap measurements are accurate within their limits of calibration. Sphere gaps with  $\frac{1}{2}$  to 1 megohm of wire resistance in series may be used satisfactorily on any "constant" potential generator.

<sup>71</sup>W. Duane, Proc. Nat. Acad. Sci., 1927, XIII, 668.

<sup>72</sup>E. Quimby, Am. Jour. Roentgenol. and Rad. Ther., January, 1929, XXI, 64.

<sup>73</sup>W. Duane, J. C. Hudson, and H. N. Sterling, Am. Jour. Roentgenol. and Rad. Ther., September, 1928, XX, 241.

<sup>74</sup>L. S. Taylor, Bureau of Standards Jour. Research, 1930, V (R. P. 212), 517; to be published in RADIOLOGY.

<sup>75</sup>E. Quimby. See Footnote 72.

<sup>76</sup>L. S. Taylor. See Footnote 74.

<sup>77</sup>A. Mutscheller, RADIOLOGY, April, 1930, XIV, 385.

<sup>78</sup>L. S. Taylor, Bureau of Standards Jour. Research, 1930, V (R. P. 217), 609; to be published in RADIOLOGY.

# ROENTGENOLOGICAL APPEARANCE OF INTERLOBAR AND MEDIASTINAL ENCAPSULATED EFFUSION IN THE THORAX

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THE difficulty of establishing a clinical diagnosis of encapsulated effusions in the thorax has long been recognized. Roentgenology has taken a significant place

in the diagnosis of interlobar pleura and mediastinum. With two exceptions, all the cases were proven by operation or autopsy.

Clairmont (2) divides the encapsulated

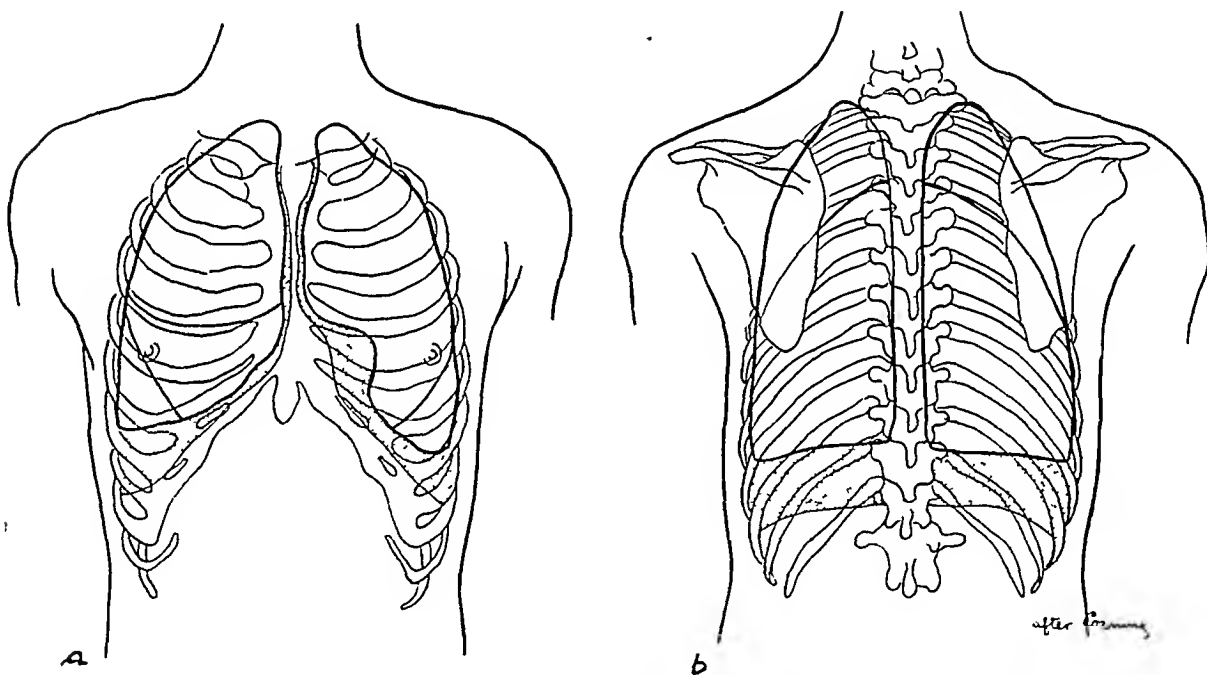


Fig. 1. Front (a) and back (b) views of thorax, showing the relations of the interlobar septa and lungs to the chest wall *After Corning*

as a diagnostic measure in checking the presence, location, and extent of these effusions as indicated by the clinical examinations and may reveal effusions not suspected by the most careful clinical study.

The present contribution is an investigation of the roentgenologic examination of these effusions as they occur in the inter-

lobar pleura and mediastinum. With two exceptions, all the cases were proven by operation or autopsy.

- (1) Para- and metapneumonic infections.
- (2) Infections through the blood stream (following tonsillitis, puerperal infections, scarlet fever, etc.).
- (3) Infections through the lymph stream from subphrenic abscesses, peritonitis.

- (4) Infections in tuberculosis.
- (5) Infections through chest wounds.

To these may be added, as a sixth group, the encapsulated effusions which occur from the passive hyperemia as a result of cardiac

lobes. One of the incisuræ is similar in its position and relation to the fissure in the left lung. It is directed, however, more vertically and separates the lower lobe from the middle and upper lobes. The second incisura

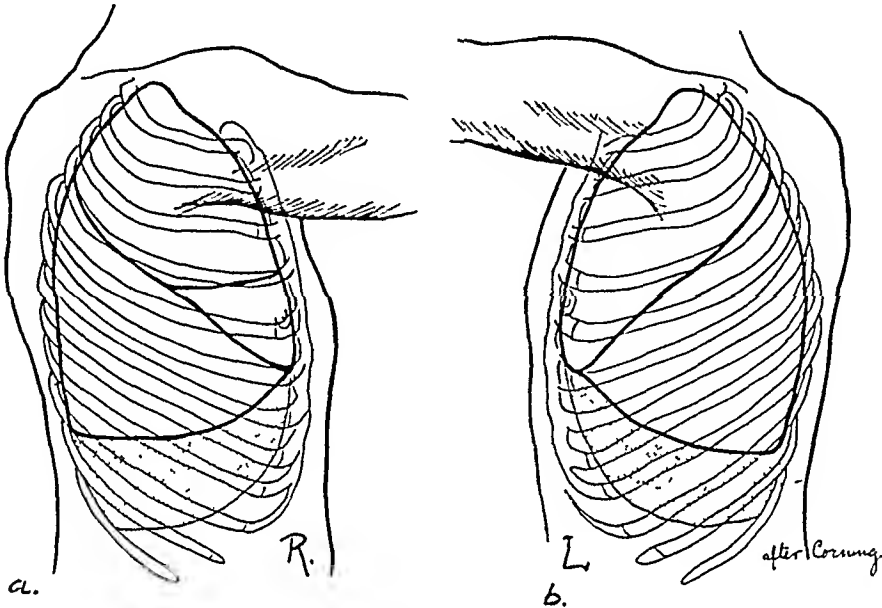


Fig. 2. Right (a) and left (b) lateral views, showing the interlobar septa. *After Corning.*

incompetence. Effusions may be situated in any part of the pleural cavity, but the interlobar and the paramediastinal spaces are the sites where their clinical detection causes most of the difficulties.

#### THE INTERLOBAR EFFUSION

A brief recapitulation of the anatomical situation of the septa will aid in understanding the problem.

The left lung is divided into two lobes by a long fissure, the incisura interlobaris. Viewed from the costal surface, it begins dorsally about 5 cm. below the apex, about the level of the vertebral end of the third rib, and is continued downwards and ventrally to the diaphragmatic surface of the lung.

In the right lung there are two incisuræ interlobares which subdivide it into three

lobes. One of the incisuræ is similar in its position and relation to the fissure in the left lung, and proceeds ventrally, ending at the level of the fourth costal cartilage. The middle lobe of the right lung is triangular or wedge-shaped (Figs. 1 and 2).

The interlobar effusions occur more often after a pneumonia than from the other causes enumerated in the first part of this article.

The localization of the process corresponds to the course of the interlobar fissure. A shadow extends from the hilum to the lateral chest wall in a vertical or oblique direction and at different levels of the lung fields, according to which part of the fissure is involved. The size and form of the shadow is manifold, depending on the amount of the fluid and the compressibility of the neighboring lobes. Usually the lower lobe is compressed and in such cases the upper border of the shadow is



sharp, and the lower border somewhat less distinct in the postero-anterior view. Small exudates which do not compress the lung are often band- or wedge-shaped and the larger ones are circular.

Otten (6) mentions the differential diagnostic fact that interlobar effusions are separated from the hilum by a narrow band of air-containing lung, but Assmann (1) and Fleischner (5) do not consider it as an infallible sign, stating that such an appearance occurs only if the medial part of the fissure is already obliterated. In the lateral view the shadows often overlap the heart, are ribbon- or wedge-shaped, and have straight or circular, but always sharply defined, borders. The diaphragm remains in normal position and moves freely. If, because of a complicating pneumonia, atelectasis, or effusion into the entire pleural cavity, the whole lung field becomes hazy, the roentgenologic examination cannot contribute much of value toward the diagnosis.

Fluoroscopic examination and films taken at different angles are essential, unless the patient's serious illness prohibits too much motion. Attention is called to the importance of the lateral views, which often give a clearer picture of the extent and exact location of the process, than do the routine stereoscopic and postero-anterior views.

Unquestionably at times these effusions are difficult to diagnose, principally when gas or air escapes into the interlobar space, giving the roentgenologic appearance of a lung abscess. The other diseases which can simulate the appearance of interlobar effusions are the pneumonias (particularly those of the right middle lobe and those which involve parts of the lobes situated near the septa, the so-called marginal pneumonias), localized caseating processes, and bronchial carcinomata.

Lobar pneumonia may cast a shadow in the postero-anterior view, similar to an interlobar process, but the lateral view will

show that the entire lobe is clouded and the process ends at the interlobar septum. The marginal pneumonias and the localized caseations near the septa have one sharply defined border but their other borders will usually be irregular, merging gradually into the air-containing lung.

Occasionally an interlobar effusion may be present simultaneously with a pneumonic consolidation. If the pneumonia involves all the lobes of one lung, the roentgenologic examination, as stated before, will be of little value, but if only one lobe is involved, the presence of an interlobar effusion may be detected by a diagnostic sign which was first noted by Fleischner (4). He describes a case in which a pneumonic consolidation of the left lower lobe was present. Examining the patient in the lateral position he found that the consolidation extended from the interlobar septum downward and posteriorly. In the posterior part of the lower lobe the area of consolidation gradually merged into normal lung, but the interlobar septum, instead of being straight, showed a marked anterior bulging, which Fleischner (4) interpreted as an interlobar effusion surrounding the anterior border of the pneumonic area. Subsequently 500 c.c. of serous fluid were removed by a long needle inserted in the posterior axillary line. Roentgenologic examination after the thoracocentesis showed an encapsulated, localized hydropneumothorax in the region of the interlobar fissure, confirming his diagnosis.

The bronchial carcinomata, being invasive and infiltrative in character, do not cause difficulties in the differentiation, but, as our Case 7 shows, they may have clear-cut outlines and may be situated in the region of the interlobar septum. In these cases lipiodol injection into the trachea reveals the nature of the lesion, by visualizing the defects and irregularities of the bronchial contour produced by the tumor. The differentiation between interlobar hydropneumo-



Fig. 3. Case 1. Interlobar effusion, showing an atypical shadow at the left base.



Fig. 4. Case 1. Lateral view, showing the basal shadow to be projected into the lower part of the left interlobar fissure.

thorax, encapsulated hydropneumothorax around the anterior or posterior chest wall, and lung abscess, according to Assmann (1), is at times almost impossible, and only through repeated, careful examinations can the diagnosis be approached.

A carefully taken clinical history and close co-operation between the clinician and roentgenologist are of paramount importance in these diseases.

#### CASE REPORTS

Case 1. L. D. (No. 50,863), colored female, 28 years of age, was admitted to the City Hospital on January 27, 1930. Her illness started six weeks previous to that time with pneumonia. Since then she had had a slight cough, especially at night. There has been no hemoptysis.

On physical examination the lower left lung was found to be dull, with diminished

tactile and vocal fremitus and breath sounds throughout this area. Her temperature on admission was  $37.8^{\circ}$  C., and remained at about the same level during the first days of her stay in the hospital. On the day after admission thoracocentesis was done and 20 c.c. of creamy material were removed. No organisms were found in it.

Roentgenologic examination on January 30th showed, in the postero-anterior view, a shadow of increased density throughout the medial two-thirds of the distal left lung, which extended to the diaphragm and had a semicircular, somewhat lobulated outer border (Fig. 3). The lateral view showed the same shadow to be wedge-shaped, extending from the anterior border of the diaphragm upward and posteriorly to the hilum (Fig. 4).

At operation by Dr. S. O. Freedlander on February 1st, the eighth rib was resected in the mid-axillary line for a distance meas-

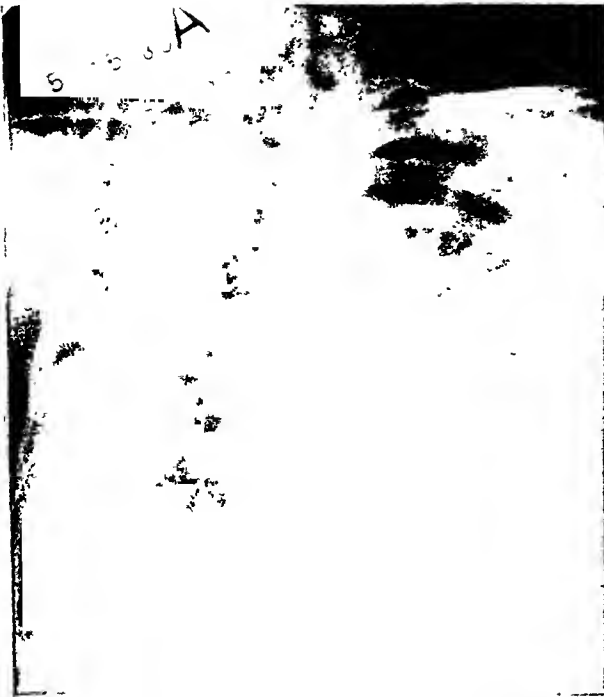


Fig. 5. Case 2. Interlobar effusion extending into the mediastinal space and showing a double left cardiac silhouette.



Fig. 6. Case 2. The interlobar character of the effusion is well seen in this semi-lateral view.

uring 7.5 centimeters. On aspiration, thick yellow pus was obtained. An opening was made in the pleura and a rubber tube inserted in the cavity containing the pus.

In this case the interlobar character of the effusion was clearly demonstrated in the lateral view, which showed the shadow to be situated in the course of the interlobar fissure. The operation substantiated the findings, there being found a collection of pus in this area.

Case 2. A. S. (No. 53,348), white male, 46 years of age, by occupation a moulder in a foundry, was admitted to the City Hospital on May 14, 1930. The patient had been ill for the past thirteen months, almost continuously. He had had pneumonia at the onset of his illness. After that he had complained of almost constant pain in the chest, much worse during the last two weeks, when he had begun coughing more profusely and expectorating small amounts of sputum, not of foul odor. There had

been no hemoptysis. During the last year the patient had lost 17 pounds in weight.

*Physical examination.*—Percussion note was dull over the base of the left lung posteriorly, up to the level of the fourth rib. Breath sounds were distant over the dull area, but high pitched in character. There was slight decrease in tactile fremitus. Thoracentesis was done on the day of admission in the left ninth intercostal space, posterior axillary line. Three c.c. of slightly turbid, yellow fluid were obtained, which contained 8,750 cells, with 90 per cent polymorphonuclear cells in disintegrated condition. The temperature during the first few days in the hospital varied between 37.5 and 39.8°C.

Films taken on May 15th showed a dense cloudiness at the left base, reaching the level of the fifth rib in the mid-axillary line. The cloudiness extended higher around the left border of the heart as a wide ribbon-shaped shadow, giving the heart silhouette a double contour. There was also a suggestion of a

slight amount of free fluid in the phrenicocostal sinus. The rest of the lungs showed beaded bronchial markings, suggesting pneumoconiosis (Fig. 5). Corresponding to the shadow at the base, in the semilateral view a wedge-shaped shadow was seen, which extended from the dome of the diaphragm to the hilum region (Fig. 6).

On June 3rd lipiodol was injected into the left main bronchus and subsequent films showed no evidence of bronchial obstruction. The distal ends of the bronchi being visualized, it was possible to determine that the lower lobe was displaced posteriorly and laterally. The roentgenologic diagnosis of interlobar pleural effusion was made. On account of the double contour of the left border of the upper heart shadow, it was suggested that some of the fluid extended into the mediastinal space. The possibility of a primary bronchial carcinoma was also considered at first, but this was excluded by the normal appearance of the visualized main bronchus.

The patient was operated on by Dr. S. O. Freedlander on June 11th. Incision was made over the ninth rib in the posterior axillary line and an area measuring 10 cm. in length was removed. An attempt to find the abscess was unsuccessful. The tenth rib was resected then and about 10 cm. of it removed. The lower lobe was covered by much thickened pleura and was adherent to the posterior chest wall. After many attempts an empyema cavity was located and entered, which contained 500 c.c. of thick, foul-smelling pus. This cavity was evidently situated between the pericardium medially, lower lobe behind, diaphragm below, and upper lobe above. A drainage tube was inserted and the skin partly sutured.

In this case, besides the interlobar effusion which is not obvious in the postero-anterior view, the ribbon-shaped shadow around the left border of the heart is worthy

of note—the characteristic appearance of the mediastinal effusions. In one of our cases which we shall discuss later, we had the opportunity to prove the nature of a similar shadow by autopsy.

Case 3. W. P. (No. 53,145), colored male, 12 years of age, was admitted to the Sanatorium of the City Hospital on June 15, 1930. The patient's left wrist had become swollen on the palmar surface in November, 1929. It soon ruptured and began draining. During December and January the right wrist became swollen and also started to drain. Both continued to drain at intervals. The patient had had cough and expectoration for the last four months. The lungs were clinically negative. The clinical diagnosis of tuberculous synovitis of both wrists was made, and the patient was referred to the roentgen-ray department for an examination of the chest.

Films taken on June 26th showed an interesting, somewhat circular shadow between the seventh and tenth ribs, which measured about 8 cm. in diameter. The shadow was sharply defined, with the exception of the lateral circumference, which was irregular (Fig. 7). The lateral view showed the interlobar septa between the upper and middle lobes and between the middle and lower lobes to be thickened. The shadow seen in the postero-anterior view as circular, was more wedge-shaped in appearance and situated at the junction of the thickened interlobar septa (Fig. 8).

On account of the clinical diagnosis of tuberculosis, aspiration was not attempted. In this case, besides an interlobar effusion, a localized caseation of the right middle lobe was considered. Assmann (1) demonstrates in his text-book an antero-posterior view of a very similar case, which at autopsy was found to be a localized caseation in the right middle lobe.

The lateral view in our case demonstrates that the shadow does not involve the ante-



Fig. 7. Case 3. Encapsulated effusion at the junction of the interlobar septa on the right side.



Fig. 8. Case 3. The shadow is sharply defined and projected into the center of the right lung in the lateral view.

rior part of the region of the right middle lobe, and that its anterior border is sharp.

Case 4. E. H. (No. 48,877), white male. 76 years of age, was admitted to the City Hospital on September 2, 1929. He was confused and did not remember recent dates well. A few days before, he had had a fainting spell, striking his forehead. He thought he had not passed any urine for the last three or four days. Catheterization yielded about 5 c.c. of very bloody urine. The abdomen was markedly distended and tender.

The clinical diagnosis of ruptured bladder was made and 50 c.c. of air was injected into the bladder. Subsequent films showed free air under the right diaphragm, confirming the clinical diagnosis. The same films

also showed marked enlargement of the left ventricular region. There was a well demarcated, circular shadow of increased density near the upper border of the right hilum, measuring about 6 to 7 cm. in diameter (Fig. 9).

At autopsy on September 4th a ruptured bladder was found, and 2 liters of hemorrhagic fluid in the peritoneal cavity. The patient also had had an aneurysm of the posterior wall of the left ventricle, and coronary occlusion.

Corresponding to the circular shadow near the right hilum, a localized interlobar effusion was found between the upper and middle lobes, well encapsulated, containing about 60 c.c. of clear fluid. Helm (5) and Fleischner (4) each describe a similar case



Fig. 9. Case 4. Interlobar effusion due to circulatory disturbance.

in which a serous interlobar effusion was found—and proven by autopsy—in patients suffering from circulatory disturbances.

Case 5. C. B. (No. 53,167), white female, 39 years of age, was admitted to the City Hospital on August 9, 1930. The patient complained of having coughed up about one-quarter of a cupful of blood four days before admission, the blood coming after a severe coughing spell. The next day she had had another hemorrhage, bringing up about a half-cupful of bright red blood, not clotted. There had been no pain before or during the hemoptysis. The patient had always been well until April, 1930, when she had had a hemorrhage, similar to the recent one.

The temperature during the first few days of her stay in the hospital varied between 36.5 and 38.0°C. The sputum was negative for tubercle bacilli on August 22 and 23, 1930. The lungs were negative clinically. Chest films taken before admission (on April 28, 1930) showed a few calcified nod-



Fig. 10. Case 5. Oval shadow of increased density near the right hilum. The shadow is not sharply defined and appears not unlike an area of parenchymatous infiltration.

ules in a slightly enlarged right hilum, but no parenchymatous shadows were seen.

Films taken on August 20, 1930, showed a poorly defined oval shadow of increased density partly overlapping the right hilum, measuring 5 by 2 centimeters. In the lateral view this shadow was seen as a band of increased density, extending from the hilum to the anterior chest wall, situated along the course of the interlobar septum between the middle and upper lobes, and sharply defined. A roentgenologic diagnosis of interlobar pleural effusion was made (Figs. 10 and 11). A film taken on September 3rd no longer showed the oval shadow. The right hilum was still enlarged.

Taking into consideration the repeated hemoptysis, the patient's temperature, which stayed at the previous level even after the effusion had absorbed, and the enlarged right hilum, it is probable that the effusion was tuberculous in etiology.

This case presented unusual interest in that the effusion was not sharply defined in the postero-anterior view and closely sim-



Fig. 11. Case 5. In the lateral view the shadow is sharply defined, ribbon-shaped, and situated in the interlobar fissure between the right upper and middle lobes.



Fig. 12. Case 6. Interlobar hydropneumothorax simulating an ulcerative area in the region of the right upper lobe.

ulated an area of perihilar parenchymatous infiltration. In the latter case, of course, the prognosis would have been considerably more grave.

The complete examination, fluoroscopically, and films taken with the patient rotated at various angles is one of the most important factors in establishing the diagnosis, and if these factors are neglected, errors are almost unavoidable. Stereoscopic films alone are not sufficient in these cases.

In one of our cases, in which we neglected to carry out a complete examination, the roentgenologic diagnosis was erroneous at first, a closer diagnosis was established later, but the true nature of the lesion was revealed only during operation.

Case 6. J. Q. (No 34,439), white male, 53 years of age, was admitted to the City Hospital on June 28, 1926. The patient had had a chill on June 22nd, with nausea

and vomiting. These symptoms were followed by a sharp, continuous pain in the right chest, and during the three days before admission the patient brought up about 150 c.c. of blood each day. Clinically, at this time the patient had signs of consolidation in the right upper lobe. The sputum was negative for tubercle bacilli on July 4th and again on July 6th. The temperature varied between 37 and 38°C. during the first few days of the patient's stay in the hospital. Films taken on June 26th showed the upper half of the right lung to be increased in density, suggesting a pneumonic consolidation.

The patient's temperature continued and soon after this examination he began to expectorate about half a cupful of foul-smelling sputum daily.

Stereoscopic films taken on July 10th showed a marked change. There was a



Fig. 13. Case 6. Film taken two months later after injection of lipiodol into the empyema cavity. The cavity is smaller and its connection with the bronchi is visualized.



Fig. 14. Case 7. Bronchial carcinoma producing a shadow of increased density between the second and fourth anterior right ribs.

horizontal fluid level opposite the third rib anteriorly and above this a large semicircular radiant area, suggesting a cavity, occupying about one-third of the lung (Fig. 12).

The third series of stereoscopic films (taken on July 27th) showed no change. At this time it was suggested that, besides an ulcerative area, an encapsulated hydropneumothorax should be considered also. On July 28, 1926, aspiration was attempted in the third anterior intercostal space and 10 c.c. of seropurulent fluid were withdrawn.

The patient was operated on by Dr. S. O. Freedlander on August 24th, an incision being made over the right third rib in the anterior axillary line. About 4 cm. of the rib were removed subperiosteally. Incising the thickened pleura, a cavity was entered, measuring 8 cm. in diameter. It extended upward, posteriorly and medially, had a thick smooth wall, and contained a small amount of thick yellow pus. It seemed to be

situated between the upper and middle lobes. In the upper medial portion of the cavity adjacent to the mediastinum there was a large bronchial fistula. A tube drain was inserted and held in position by silkworm gut.

On October 19, 1926, lipiodol was injected into the drainage tube and subsequent films showed an empyema cavity about the size of a thumb. The cavity apparently opened into some of the bronchi, as they were filled with the contrast material. Most of the cloudiness in the right upper lobe had disappeared by this time, only an oval shadow of increased density remaining in the region of the right upper mediastinum (Fig. 13).

The difficulty of differentiating interlobar empyema from a primary bronchial carcinoma is well illustrated in the following case.

Case 7. J. S. (No. 52,199), white male, 54 years of age, was admitted to the City Hospital on March 10, 1930. The patient





Fig. 15. Case 7. Bronchial carcinoma shown in the region of the septum between the right upper and lower lobes, with sharp anterior and posterior borders.



Fig. 16. Case 8. Mediastinal pleural effusion, producing a double cardiac silhouette on the left.

had been ill for the last two years, with loss of appetite and fever. Cough began about two or three months after the onset, and continued—severe at times. There had been several periods of blood streaking, but no hemoptysis. The patient expectorated about one sputum-boxful a day. Since the onset of the disease, he has lost about 25 pounds in weight.

The percussion note was dull over the right upper lung and hyperresonant elsewhere. Breath sounds were diminished throughout the right lung and exaggerated throughout the left. The temperature on admission and during the following days had a septic character, varying between  $37.5$  and  $40^{\circ}\text{C}$ . The white blood count was 26,400.

Films taken before admission to the hos-

pital (on February 26, 1930) showed a dense, even cloudiness between the right second and fourth anterior ribs, extending from the heart shadow to the lateral chest wall. In the lateral view the shadow was projected into the region of the upper and posterior portion of the interlobar fissure between the upper and lower lobes, with its apex looking toward the hilum and its base toward the posterior chest wall. The shadow was sharply defined and had all the roentgenologic signs of an interlobar pleural effusion (Figs. 14 and 15).

A few days after admission withdrawal of the fluid was attempted, but none was found. Lipiodol was injected into the right main bronchus on March 13th and subsequent films showed a pneumothorax with a

fairly good collapse of the right lung, apparently produced by the attempted thoracocentesis. The lung was well outlined. The right main bronchus about 1 cm. below the bifurcation showed a narrowing and fine irregularity of its contour, throughout an area measuring about 2 cm. in length. This narrowing was more in favor of a bronchial carcinoma than of an effusion.

Bronchoscopic examination was done by Dr. C. W. Engler and five small pieces of soft tissue were removed from the right main bronchus, just below the bifurcation. The pathological diagnosis of the specimen was "small cell carcinoma."

This case had the typical roentgenologic appearance of an interlobar effusion. Its upper and lower borders were sharply defined, whereas in lung tumor one would expect to find irregular borders, gradually merging into the normal lung field. Fluoroscopically, there was no evidence of bronchial obstruction and the heart remained stationary during respiration.

The injection of lipiodol was of considerable help in establishing the diagnosis, showing the filling defect in the main bronchus. The other diagnostic aid was the involuntary pneumothorax, with complete outlining of the lung. In a chronic interlobar effusion, the surrounding pleura would be thick enough and adherent enough to prevent a collapse.

#### MEDIASTINAL PLEURAL EFFUSIONS

Mediastinal effusions were clinically first described by Laennec (9) and then by d'Andral (9), Cruveilhier (9) and Dieulafoy (9). The first roentgenologic description was given by Devic and Savy (9) in 1910. It is not a disease of the mediastinum as one would conclude from its name, but an intrapleural process, localized in the mediastinum.

The serous forms of these effusions are mostly of tuberculous origin and the purulent forms of pneumococcal origin. The causative germs extend into the mediastinal pleura from tracheobronchial lymph nodes, from the lungs, from the pericardium, and from disease of the thoracic wall and the different organs of the mediastinum.

They are divided into four groups: The right or left, anterior or posterior effusions. Combinations of anterior and posterior effusions of the same side occur often; combinations of the right and left effusions are rare.

The anterior mediastinal effusions according to Savy are represented by ribbon-shaped shadows, parallel to either the left or the right cardiac silhouette, and producing a double cardiac contour on the diseased side.

The posterior mediastinal effusions produce either ribbon-shaped shadows running parallel to the left or right borders of the vertebral column, or triangular shadows in the cardiophrenic angles. The base of these shadows is upon the diaphragm and their apices are directed toward the hilum.

From a differential diagnostic standpoint pericardial effusions have to be considered at times, as the triangular right-sided mediastinal effusions may give a similar roentgenologic picture. These effusions, however, do not fluoroscopically show transmitted pulsations from the heart, whereas in case of pericardial effusion the pulsations of the heart can be seen. Furthermore, by rotation of the patient, the effusion can be projected away from the heart shadow.

The triangular shadows may imitate the bronchiectatic triangular shadows, occurring in the same region. Many of the bronchiectases are well localized in the cardiophrenic sinuses, and once the surrounding lung tissue becomes consolidated, or the diseased lower lobe collapsed (pseudo-empyema bronchiectaticum, Epstein, 3), the differentiation between the two conditions becomes

almost impossible. The exploratory thoracentesis is of no value in these cases either, because if the needle enters a bronchiectatic cavity, a few cubic centimeters of fetid pus can be withdrawn, establishing the erroneous diagnosis of empyema and submitting the patient to a valueless operation (Berthold Epstein's case). The only way to establish the diagnosis is to inject lipiodol into the bronchi, and determine whether or not they are dilated. Rist (7) is of the opinion that every patient who shows a triangular shadow in either of the cardiophrenic angles should be submitted to bronchography before any operation is undertaken.

According to the situation of the effusions, at times mediastinal tumors, aortic aneurysms, or paravertebral abscesses have to be ruled out. In the latter case a roentgenologic examination of the dorsal vertebræ will demonstrate the narrowing of the intervertebral spaces or bone destruction, establishing the diagnosis of Pott's disease. An aortic aneurysm shows pulsations, which are absent in a mediastinal effusion. Mediastinal tumors can be recognized by their lobulated contours.

The following cases are illustrations of mediastinal effusions.

Case 8. J. W. (No. 53,343), colored male, was admitted to the City Hospital on April 27, 1930. Four days before, the patient had had a chill, followed by fever, began to have a cough, and raised a considerable amount of sputum. Next day he had severe pain in the left upper and lower chest.

*Physical examination (April 27, 1930).*

—The patient was markedly dyspneic and cyanotic. Expansion was lagging on the chest. There was a dullness below the left clavicle, with bronchial breath sounds and fine râles. On the 30th the breath sounds were diminished at the left base, but the signs of pneumonia were still confined to the left upper lobe. On May 6th there was a

pleuropericardial friction rub at the left apex. On the 12th the patient had a rigid neck, a positive Brudzinski, and a suggestive Kernig sign. His temperature was septic in character, varying between 38.2 and 40.5°C. Death ensued on the following day.

Films taken on May 8, 1930, showed a sharply defined ribbon-shaped shadow of increased density around the left border of the heart shadow, giving a double contour to the left cardiac silhouette. The shadow extended from the hilum to the diaphragm. The aortic knob and right cardiac silhouette had a normal appearance. The heart was displaced to the right. The bronchial markings throughout the entire left lung were increased in density, and the same lung showed diminished air-content. The left diaphragm was higher than the right, due to a large gas bubble in the splenic flexure. On account of the pleuropericardial friction rub, a metapneumonic pericardial effusion was considered clinically, but the roentgenologic examination favored a mediastinal effusion, on account of the double left contour, and of the right displacement of the heart, which was obviously pushed aside by outside pressure (Fig. 16).

The next film taken, five days later, showed the shadow on the left to be a little smaller, less dense, but still defined with fair sharpness.

At autopsy on May 13th a small amount of inspissated yellow fibrinopurulent material was found in the anterior mid-dorsal region, well encapsulated between the leaves of the mediastinal pleura. Some of the material extended anteriorly around the base of the lung. Pericardial fluid was not increased.

Case 9. J. E., white male, 63 years of age, was admitted to the City Hospital on November 28, 1927. The patient complained of pain in the stomach and shortness of breath, which had developed about a



Fig. 17. Case 9. Encapsulated fluid near the right upper posterior chest wall; mediastinal pleural effusion and free fluid at the right base.



Fig. 18. Case 9. First oblique view showing the obliteration of the posterior mediastinal space and the circular shadow in the upper lung field.

week before. He had had some shortness of breath for the past year. It was impossible to ascertain complete details concerning the sickness, because the patient was confused.

*Physical examination.*—There was a dullness over the right upper lobe anteriorly and posteriorly and a dull percussion note was elicited at the right base posteriorly. Breath sounds were faint over the right lung and moist râles were heard over both lungs. The heart showed no increased activity or enlargement. The patient's temperature varied between 38.2 and 39.2°C. during his stay at the hospital. The white blood count on December 2nd was 12,800, with hemoglobin 85 per cent.

On December 3rd a needle was inserted at the angle of the right scapula and 275 c.c. of clear yellow fluid was withdrawn. No

growth was obtained in the culture. Death took place on December 5, 1927.

Films taken on November 30th showed a sharply defined, circular shadow of increased density in the right apex and subapical regions, measuring about 10 cm. in diameter, and separated from the vertebræ by a band of air-containing lung. The right cardiac silhouette was obliterated by a dense, band-shaped shadow, measuring from 4 to 5 cm. in diameter, extending parallel to the vertebral column from the subapical region to the base. The two shadows partly overlapped in the apex. There was an uneven cloudiness at the right base, extending to the level of the ninth rib. The thickened interlobar septa between the right upper and middle lobes, and middle lower lobes were visualized, and the former was markedly displaced downward. The heart was dis-

placed to the right. The first oblique view, besides the cloudiness throughout the entire base, showed the apical circular shadow to be situated rather posteriorly. The entire posterior mediastinal space was obliterated by the band-shaped shadow seen in the postero-anterior view near the vertebral column (Figs. 17 and 18).

Autopsy was performed on December 5, 1927. Unfortunately the pathological protocol did not describe in detail the exact location of the pathological changes in the pleural cavity, briefly mentioning that there were numerous dense adhesions between the leaflets of the pleura, which separated encapsulated sacs of localized pus collections. There was also some free purulent fluid found among the leaves of the basal pleura. The purulent fluid removed from the base and from the encapsulated sacs amounted to 780 cubic centimeters. The right lung showed a generalized fibrosis. The right lower lobe contained several gangrenous cavities. The left lung, the mediastinal organs, and heart were found normal. The band-shaped shadow overlapping the right border of the heart is a characteristic illustration of a posterior mediastinal effusion. That this effusion was situated in the mediastinal space seems to be confirmed by the left displacement of the heart and by the oblique view, showing an obliteration of the posterior mediastinum. The signs of mediastinal embarrassment, as marked dyspnea and cyanosis, were also present in the clinical picture.

#### SUMMARY

1. The interlobar and mediastinal varieties of encapsulated effusions are discussed.
2. Interlobar effusions are characterized by sharply defined band- or wedge-shaped or circular shadows in the region of the interlobar septa.

3. Lobar and marginal pneumonias, localized and well circumscribed caseous consolidations, and bronchial carcinomata must be differentiated from these effusions.

4. In the presence of a pneumonia, the only roentgenologic sign of an interlobar effusion is the bulging of the interlobar fissure, seen in the lateral view.

5. Mediastinal pleural effusions are represented by band-, wedge-shaped, or triangular shadows parallel to the vertebral column or to the cardiac silhouette.

6. Pericardial effusions, paravertebral abscesses, aortic aneurysms, mediastinal tumors, and areas of bronchiectatic consolidation may give a similar roentgenologic appearance.

7. Bronchography is a valuable aid in establishing the diagnosis in both varieties of those effusions.

The use of Dr. S. O. Freedlander's operative notes is gratefully acknowledged.

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**Potassium in Radiobiology.** Pietro Ottonello. *La Radiologia Medica*, May, 1930, XVII, 580.

According to the most recent theories, cancerous growths seem to be due, fundamentally, to either abnormal electrolytic processes or to deficiency of the intrinsic radio-activity of the cell. It should be logical to assume, therefore, that potassium, being the only substance existing in the human body which is at the same time an electrolyte and a radio-active element, should play a very definite rôle in cellular activities.

The author reviews the vast literature on the subject, and by referring in part to experimental findings and in part to plausible theories, is led to suggest the administration of potassium, either orally or intravenously, to cancer patients as an aid to X-ray or radium treatments. The suggestion is considered worth trying, potassium being harmless to healthy tissues and allegedly selective on neoplastic cells. Furthermore, even if potassium should, as has been claimed by some inves-

tigators, cause an artificial acceleration in the growth of the tumor, it would, for the same reason, facilitate further treatment by irradiation. Indeed, by activating the osmotic processes of the cell, by increasing the permeability of its membrane, and by favoring cell division in general, potassium would create essentially a sensitive stage in the life of the tumor and would render it more vulnerable to irradiation therapy.

L. MARINELLI.

**Physical Therapy and Radiotherapy during 1929.** Charles R. Brooke. *Med. Times*, February, 1930, LVIII, 55.

This review, which will be concluded in the March issue of *The Medical Times*, covers important articles on the subject of diathermy, ultra-violet, and galvanism. The review on radiation in the February issue includes the article by A. Bouwers on self-protecting tubes.

W. W. WATKINS, M.D

# ROENTGENOLOGICAL ASPECT OF VARIOUS TYPES OF COLONIC DIVERTICULA<sup>1</sup>

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SINCE the advent of the barium meal the various pathologic conditions of the colon have become of increasing interest, as by this means the character, severity, and location of the lesions can more accurately be determined. Among the various pathologic conditions studied by the opaque meal, diverticula have assumed an important place. Abbé, in 1914, discussed a case of diverticula diagnosed by Le Wald with the aid of the X-ray, and since that time a mass of comprehensive literature has been contributed on the same subject, until now nearly every phase of the predisposing conditions, the progress of development, and the roentgen signs in their various stages have been more or less fully discussed (1). The object of this paper is to review the development and the various phases of diverticula as demonstrated roentgenologically, with a brief description of the more practical roentgen-ray signs and a demonstration by means of a case report of the X-ray appearance of a ruptured diverticulum, resulting in an extra-colonic abscess.

## DEVELOPMENT

Many theories as to the development of diverticula of the colon have been advanced, but since the use of the roentgen ray in their study it has become apparent that there are many causes. The idea that they are congenital is probably farfetched, as they are almost never met with in the barium meal examination of the young. It may be possible that some of the earlier diseases of childhood, such as cholera infantum, may produce localized areas of weakened wall in

the colon that would be a predisposing factor to the development of diverticulosis. Acquired diverticula should be regarded as pathologic. Study and classification of a large number of cases seem to indicate that they are usually caused from infection and irritation from within the lumen of the colon, resulting in a localized irritation of the other layers of the tube. Such localized irritation finally allows a portion of the mucosa to invaginate itself into the submucosa, resulting in a hernia of the mucosa through the muscularis, usually at points where blood vessels penetrate the wall. The diverticulum may be single, but there are usually multiple diverticula, varying in number from 1 to 400 or more. The opening into the colon may be stenosed or as wide as the diverticulum itself, depending on the stage of development. Diverticula may involve any part of the colon, but usually are more numerous in the distal half—the iliopelvic junction is a favorite site. They may contain fecal masses and occasionally coproliths. In longstanding cases they give rise to diverticulitis, peridiverticulitis, or pericolicitis, and frequently result in adhesions to the surrounding structures. Involvements occur in males two to three times as often as in females, appearing about once in every 450 cases in adults past forty, and ten out of thirteen cases are multiple (2). The relation of diverticula to neoplasms has been variously stated, varying from 1 to 3 to 1 to 20. This apparent discrepancy in reports by various authors is probably due to a variation in the ages of their groups and to whether or not adequate medical treatment has been applied. It is self-evident that in the untreated cases the inflammatory processes would be more severe, which is un-

<sup>1</sup>Read before the Radiological Society of North America, at the Fifteenth Annual Meeting, at Toronto, Ont., Canada, Dec. 26, 1929.

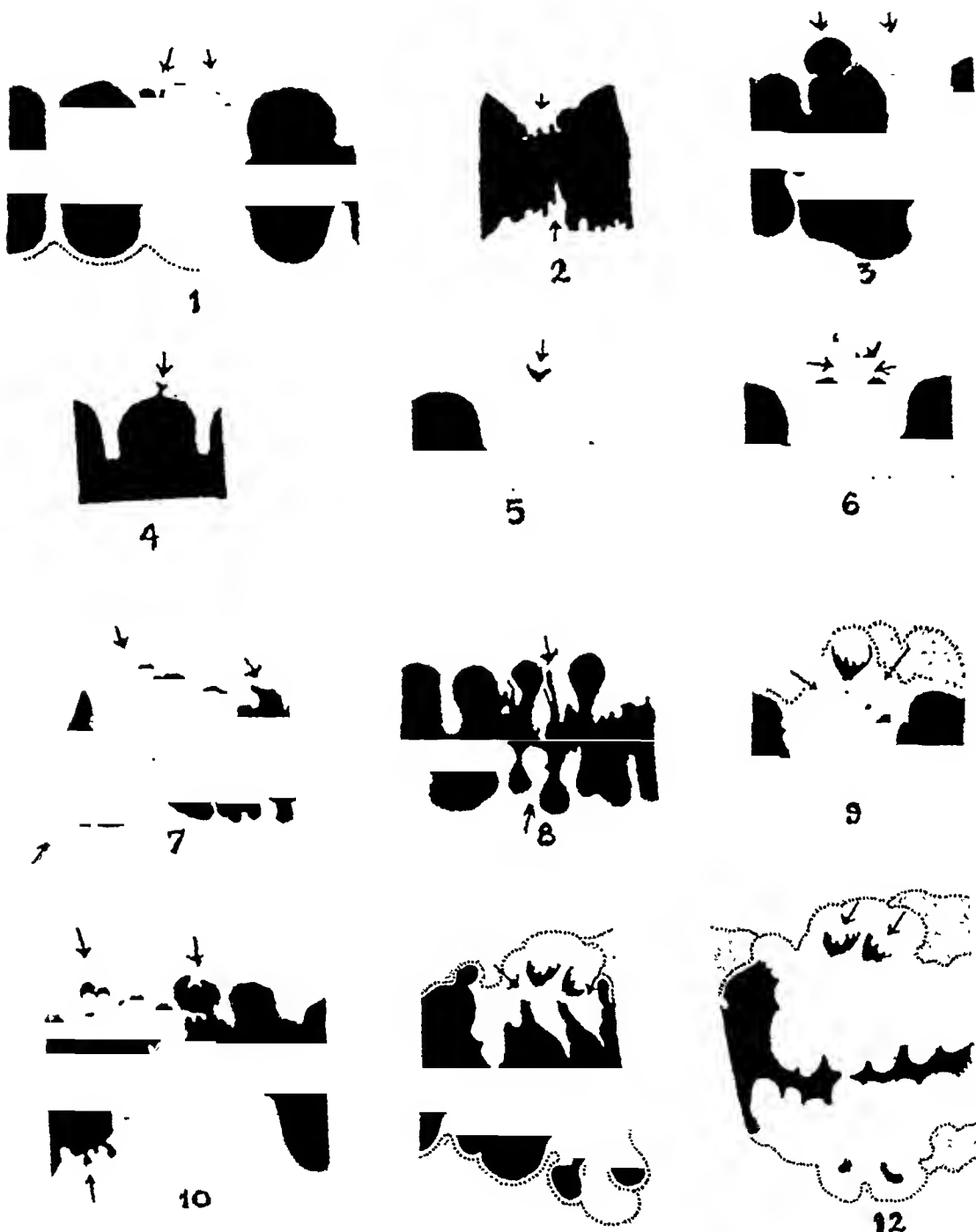


Fig. 1. A composite drawing by Spriggs and Marxer showing segments of colon, illustrating the various stages of the development of diverticula. (1) Small area showing pre-diverticular state. (2) Pre-diverticular state involving circumference of colon, causing a ring constriction. (3) Same section of bowel as shown in (2), after treatment. Signs of inflammation have disappeared, but two well-defined pouches have developed. (4) and (5) Same diverticulum observed over a period of four years, showing slow development. (6) Same type of diverticulum, showing advanced stage. (7) Section showing diverticulosis. (8) Diverticula, with signs of well-advanced inflammation. (9) Isolated diverticulum, with some thickening of the wall of the colon. (10) Well-developed diverticula supervening on areas of early inflammation. (11) Well-developed diverticulitis. (12) Same piece of bowel seven years later, showing marked increase in thickness of wall; isolation of diverticula.



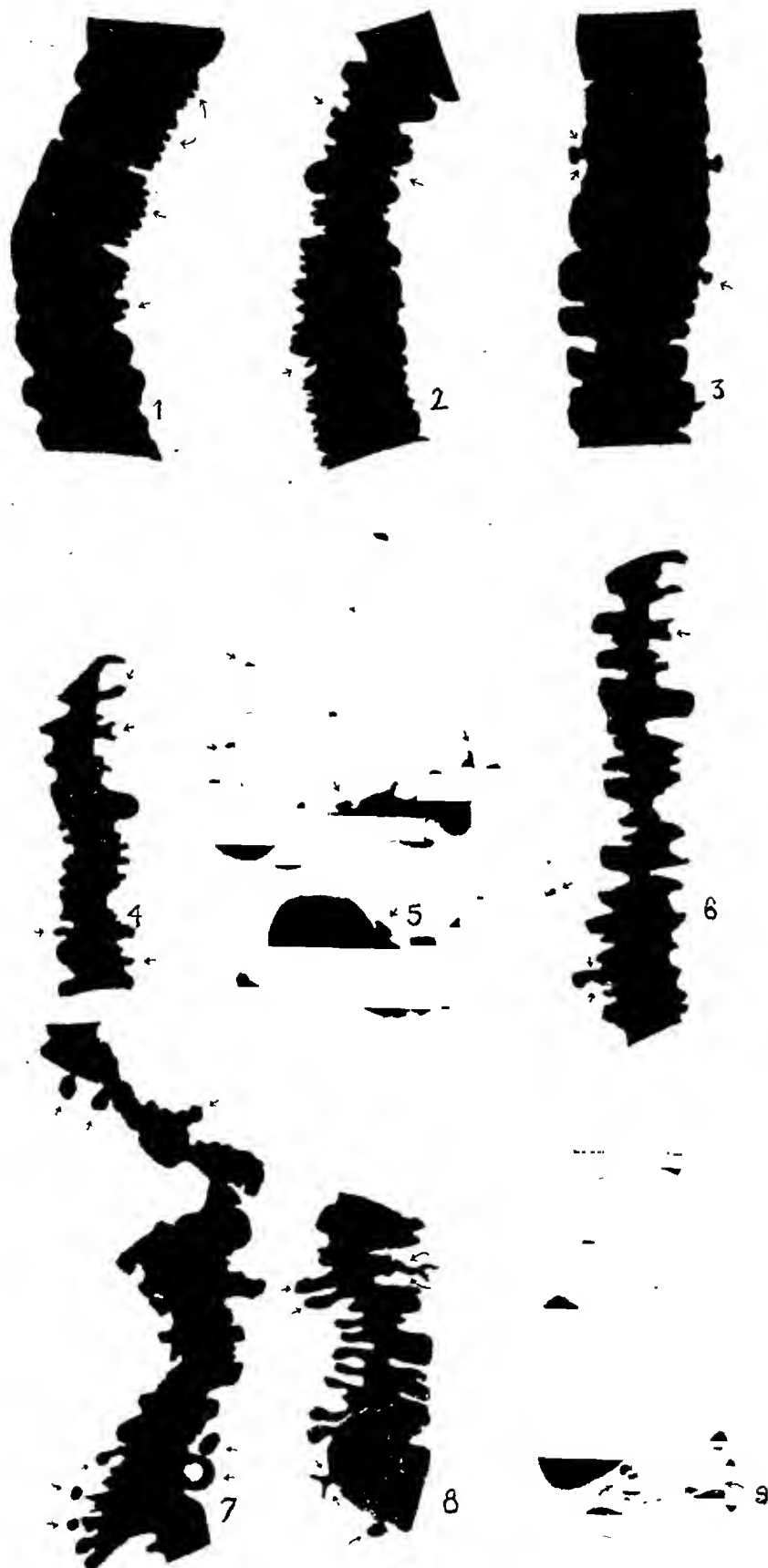


Fig. 2. Drawings from the authors' cases, showing similar conditions to those illustrated by Spriggs and Marxer. (1) Pre-diverticular state. (2) Beginning development of pouches. (3) Well-developed diverticula. (4) Early signs of inflammation, with diverticulum containing a fecal concretion. (5) Diverticulitis involving a large portion of the colon. (6) Advanced diverticulitis, with considerable narrowing of lumen of the colon. (7) Advanced diverticulitis, with apparent isolation of some of the diverticula. (8) Advanced diverticulitis showing unusual length of the re-entrant angles of some of the diverticula. (9) Advanced stage of diverticulitis localized at the iliopelvic junction.

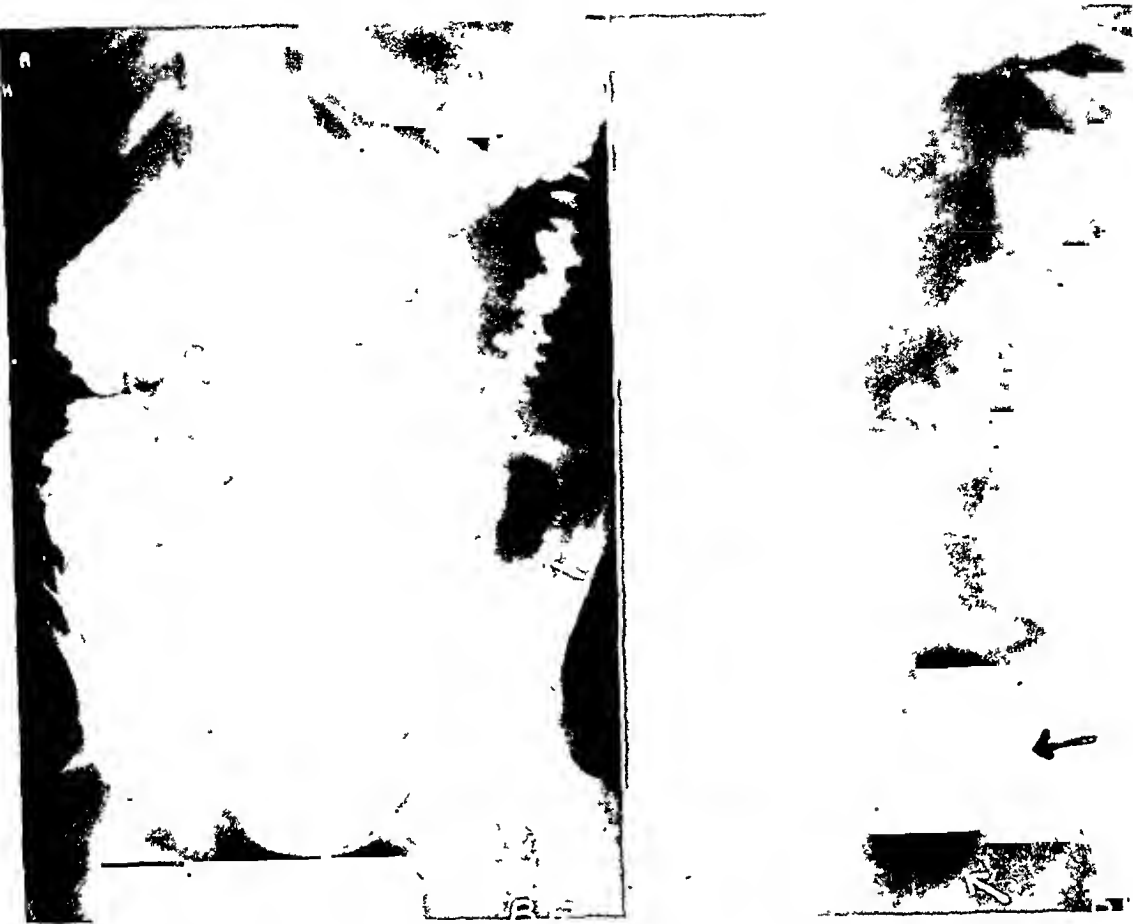


Fig. 3. Opaque enema revealing extensive diverticulitis of the distal colon. Note gas pocket marked by arrows.

doubtedly a predisposing cause of malignancy. Among the causes of diverticula, it is possible also to mention the markedly spastic distal colon, with dilated proximal colon. Under this condition the colon is subjected to considerable progressive pressure. The development of diverticulitis being a slow process accounts for the fact that most of the cases are found in adults over forty. The patients are usually well nourished and with good color. Chronic constipation is usually a factor. Blood is seldom, if ever, found in the stools in uncomplicated cases.

#### CLASSIFICATION

As far as the roentgen examination is concerned, the first classification to be men-

tioned is the pre-diverticular state in which the colon wall presents a serrated or saw-toothed appearance, with possibly some narrowing of the lumen of the affected area as first described in 1919 by George and Leonard (3). From this stage the process continues until a pouch is formed and an actual diverticulum is developed. From the deposit of fecal material in this pouch, irritation and inflammation are set up, the wall of the colon becomes thickened, the pouch becomes larger and a greater distance from the lumen of the colon, and the re-entrant angle at the neck becomes longer and more constricted. At this stage the infected material in the pouch is apt to set up inflammation, and a diverticulitis is developed. These various stages were discussed and clearly demonstrated by Spriggs and

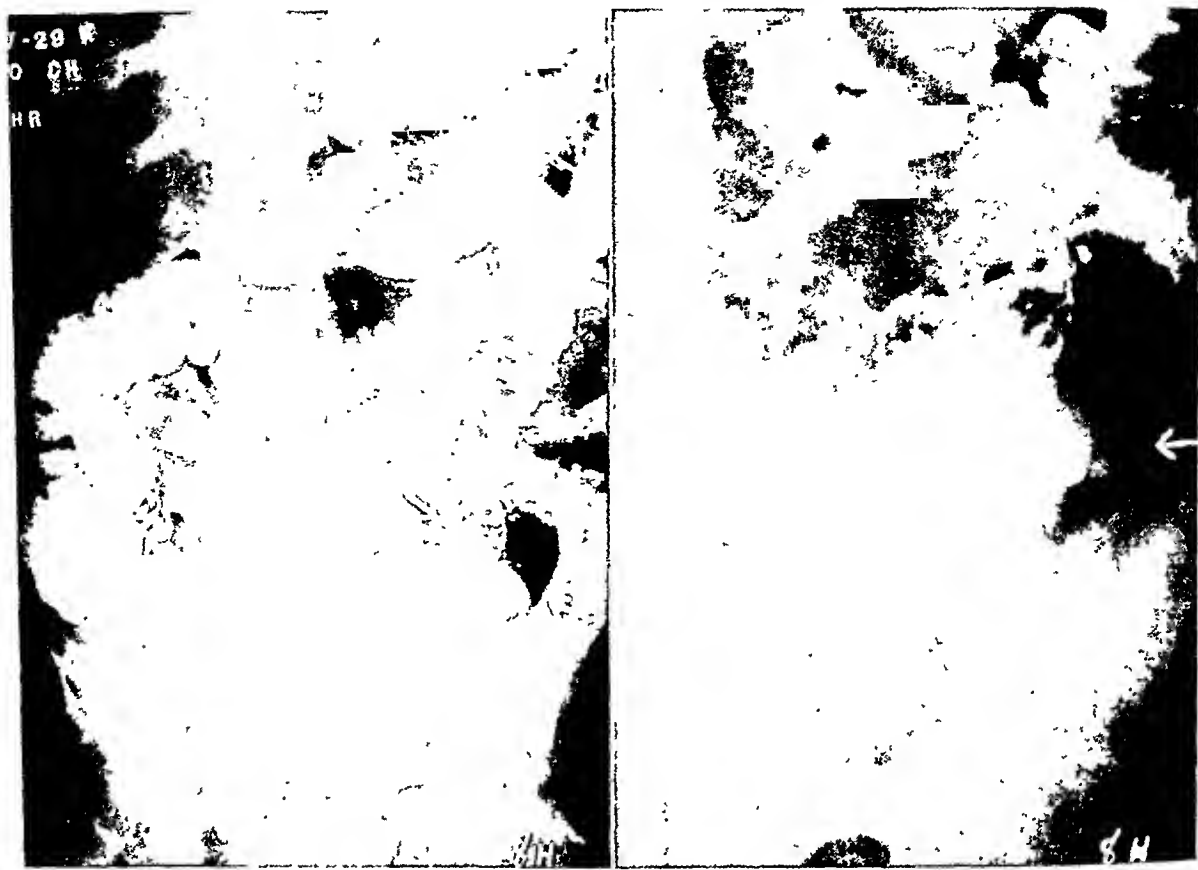


Fig. 4. Same case as shown in Figure 3; 8-hour observation. Note gas pocket at arrows, showing quantity of barium in the pocket.

Marxer in 1925 (4), and are illustrated by their drawings (Fig. 1). They had the advantage of watching the same case over a period of seven years and were able to observe the diverticulum passing through its various stages of development. A composite drawing made of some of our own cases will illustrate the various stages of the development of colonic diverticula (Fig. 2). As the irritation continues the wall of the colon becomes much thickened, the diverticulum more isolated, and symptomatology more pronounced. In a recent paper by Greensfelder and Hiller (5), attention has been called to a diverticulitis of the cecum which in its advanced stage simulates very closely the clinical picture of appendicitis.

Having the roentgenologic appearance of the numerous stages of the development of diverticula in mind, the roentgenologist is

justified in not only reporting the actual condition found, but should draw attention to the prognosis and the ultimate outcome to be anticipated. If the signs of diverticulitis are pronounced, he should carefully note the area and extent of the colon involved, the thickness of the wall as compared to the lumen, noting carefully the size of the diverticulum, whether or not it contains fecal concretions, and especially, if possible, the length and size of the neck. In instances in which the diverticula are grouped, the possibility of their being associated with carcinoma should be borne in mind. Malignancy and diverticulitis may co-exist and in our own observations seem to do so in from 10 to 15 per cent of cases. Surely if the infected material in the diverticulum becomes isolated a dangerous process is apt to develop, and the rather rare



Fig. 5. Same case as shown in Figure 3; 50-hour observation. Gas pocket still in evidence. Standing film (on right), showing fluid level in pocket.

condition of a rupture through the outer wall of the colon may ensue, resulting in an extra-colonic abscess. If this condition has occurred, it is possible for the roentgenologist sometimes to detect it, as the case report which we wish to present will illustrate.

Mrs. S., age 63. Patient first noted pain in the left side about three years before examination. Pain at that time was very severe, seeming to radiate across the lower abdomen just above the symphysis pubis, and lasted about two days. There was definite tenderness. No mass was felt. There was no nausea nor vomiting. The pain disappeared, to reappear about twice a year for the following three years. The patient can think of no cause which might have brought on this pain, as strain or undue muscular

exertion. Pain came and went spontaneously, though it was somewhat relieved by cathartics and hot compresses. She has not been constipated during the last three years. Five weeks before the patient came to the hospital, the pain returned with great severity. It was first noticed about midnight, when the onset was sudden, and was of a severe, sharp, shooting, cramping character, starting in the left lower quadrant, radiating directly across the abdomen just above the symphysis pubis. As before, there was no nausea nor vomiting. No urinary changes. No straining or coughing. Pain was relieved at this time by hot applications. Next day the pain was better, but that night returned with increased severity. Pain, although more severe on the left, had risen

so that it crossed the abdomen in approximately the midline. As before, the abdomen was tense, hard, and sore to the touch. No masses, tumors, herniæ, or abrasions were noted. A doctor was called and relief was obtained by three hypodermics. This pain continued until the patient's admission to the hospital. There was vomiting only once, this after she had eaten some tomato soup. There was no definite time relation of the pain to meals as is seen in peptic ulcers. The patient had been unable to eat because of the soreness in her abdomen: food was repulsive to her, and often made the pain worse. There had been no chills and no fever; no vomiting of blood. There had been much gas on the stomach throughout the period of the illness for which she had been admitted, and some gas was passed by rectum. Relief from the pain was not obtained by flexion of the thighs upon the abdomen.

The patient had had the usual diseases of childhood, though there was no history of acute intestinal disturbances when young. She had had influenza six years before admission, but no typhoid fever, amebic dysentery, peritonitis, or gastro-intestinal diseases.

*X-ray findings of the colon.*—The cecum was normal in size and position and was freely movable. The appendix was visualized—it was directed upward and inward and partially retrocecal. There were diverticula scattered throughout the colon, more numerous in the distal half (Fig. 3). The colon—descending and iliac—showed definite signs of diverticulitis. The wall of this portion of the colon was unusually thickened and the lumen was narrow and at certain points was constricted. In addition, there was a gas-filled space outside of the colon, lying outward and posterior to the colon in the left iliac fossa, which measured nearly four inches in its greatest diameter. At the 8-hour observation this gas pocket

was found to contain considerable barium (Fig. 4). At the 24-hour and 50-hour observations, there was still a trace of barium retained (Fig. 5). At the 50-hour observation a standing film was made and a fluid level in the gas pocket was demonstrated (Fig. 5-B). It was evident that this cavity was caused by an extra-colonic abscess, probably the result of a ruptured diverticulum.

*Röntgen diagnosis.*—Diverticulitis, with an extra-colonic abscess in the left iliac fossa, resulting from a ruptured diverticulum.

*Post-operative description of operation.*—An incision four inches long was made over the left iliac region. The wall of the colon was found to be unusually thick and studded with diverticula. Adhesions were encountered everywhere. The dissection was continued downward and to the outer side of the colon and deep in the left iliac fossa an abscess containing at least 8 oz. of pus, barium, and fecal material was encountered. A drainage tube was placed in the cavity and the wound closed in the ordinary manner with chromic catgut. The skin was closed with silkworm gut. The patient made an eventful progress. A fecal fistula remained for about three weeks.

#### REMARKS

We are not making this presentation with the idea that all cases of ruptured diverticula will present this picture, but merely to show what happened in one instance, and to suggest that this and other signs should be looked for in the presence of diverticulitis. Local areas of extreme tenderness, associated with the position of the affected colon, definite fixation of a portion of the colon, extensive thickening of the wall of the colon, a palpable tumor, as well as a stationary gas pocket, should be looked upon with suspicion.

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## DISCUSSION

DR. LESTER LEVYN (Buffalo, N. Y.): If a certain nationally known slogan were to be transcribed so that it would be applicable to the field of radiology, it would sound somewhat like this, "When better colon work is done, Dr. Upson will do it." It is a privilege to pay tribute to the untiring efforts that the Doctor has made in attempting to reduce to a minimum the relatively large percentage of errors which exists in the interpretation of colon pathology. It is interesting to note that, despite the fact that diverticula were first described in 1845 and many important monographs have appeared, the most enlightening information has come since the first case was diagnosed by the X-ray by Dr. LeWald, and to-day the most valuable information can be obtained only by the X-ray. Dr. Case in his early work suggested that inasmuch as diverticula are frequently encountered without the presence of inflammation, the term "diverticulosis" be advanced to describe that type of case. I feel, however, that it is almost impossible at times to draw a line of demarcation between diverticulosis and diverticulitis. Dr. Upson described in his paper the two important roentgen signs of diverticulitis,

namely, the pre-diverticulum stage, in which the persistent serrated appearance of the involved colon is noted, and secondly, the formation of diverticular pouches. I was also very glad to hear him, in his description of the slides, emphasize the significance of Dr. Case's sign, namely, the displacement of the small bowel away from the left iliac fossa.

The question of malignancy is one of great importance. Statistics from the Mayo Clinic show that in 15 per cent of their cases, malignancy and diverticulitis co-exist.

Dr. Upson did not discuss in his paper, of course, the matter of technic, but I should like to emphasize the importance of the barium meal as being infinitely more valuable in the determination of diverticulitis than the barium enema, and also a word of warning, that when the enema is administered, it should be given, not under high pressure, because there is always the danger of a diverticulum rupturing.

The case that Dr. Upson demonstrated is of great interest, and I am quite certain it will stimulate us to look very carefully for persistent localized collections of gas. The Doctor has lived up to his reputation of telling us a great many things in a very short time, and I am personally very much indebted to him.

DR. GORDON WEBB (Owen Sound, Ontario): About three weeks ago I had a definite case referred to me by a surgeon, to see if I could help him to localize a tumor in the left lower quadrant of the abdomen. The tumor seemed to be fairly superficial, and by the aid of a barium enema I got a certain amount of opaque fluid past its site. There was no definite way in which I could localize the tumor or help the surgeon beyond this, that after I had given the enema, I had it evacuated, as is my usual practice,

This latter system has several advantages over that employing the string electrometer: (1) Insulation difficulties are less serious; (2) it is direct-reading; (3) it can be made to serve more than one ionization chamber;

The electrical circuit employed with such a device is shown below. It is identical with the arrangement originally proposed and used by Duane. It approaches the ideal in all respects, except that the ionization cham-

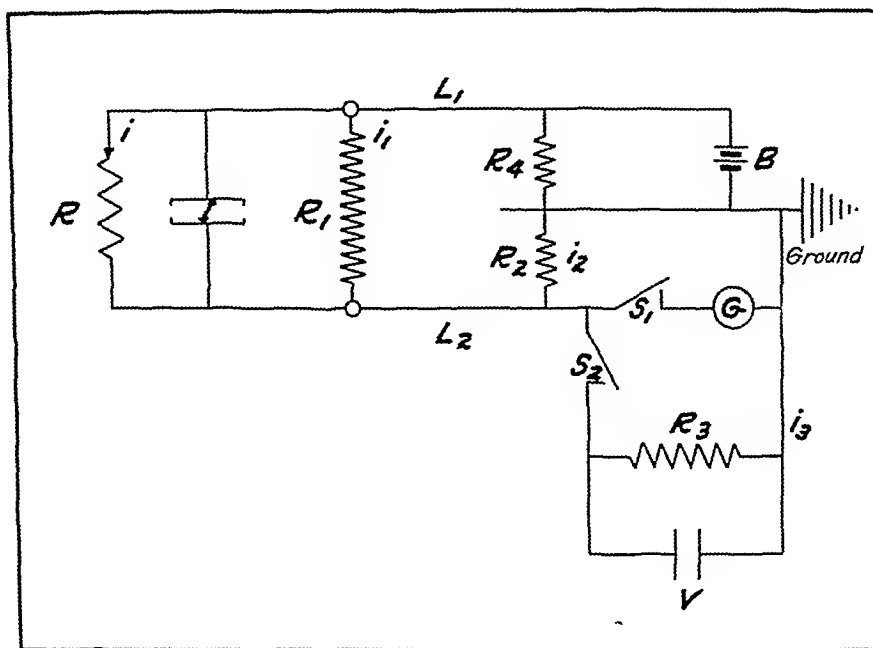


Fig. 1. Wiring diagram.

(4) the operator has better protection from stray radiation. It is, however, subject to the criticism that a high sensitivity galvanometer is a delicate instrument. Its sensitivity depends upon the fragility of a pure gold wire only seven ten-thousandths (0.0007) of an inch thick and the nicety with which this supports a coil of fine copper wire between the poles of a powerful magnet. It commands and receives respectful care. If a rugged instrument of equal sensitivity were substituted for it, many more practitioners could avail themselves of the other advantages of the system of which it is a part.

It was suggested that a new electrostatic voltmeter developed by one of us might be made to serve this purpose.<sup>1</sup>

ber cannot be made as small as the thimble type.

The new electrostatic voltmeter may be briefly described as a small quadrant electrometer in which the needle is supported by a suspension of very fine tungsten wire under tension. When a voltage is applied between one pair of quadrants and the needle, the needle will turn. By means of a small metallic concave mirror lacquered to the needle, the image of a straight filament galvanometer lamp is thrown upon a translucent scale. The position of this image upon the scale will depend upon the voltage applied to the instrument. A high resistance shunt converts the instrument into a device for measuring minute currents. When this instrument is placed in series with the ionization chamber and a battery in the position

<sup>1</sup>A description of this instrument will be published by L. P. Delaqua.

usually occupied by the galvanometer, the current flowing through the ionization chamber will also flow through the high resistance shunt of the instrument. The voltage between the two ends of the shunt will

switch  $S_1$ , in series with  $G$ , is closed.  $R_2$  and  $R_4$  represent the leakage resistance of the shielded leads to ground, and  $R_1$  the leakage resistance across the ionization chamber.  $R$  is the resistance of the gas in

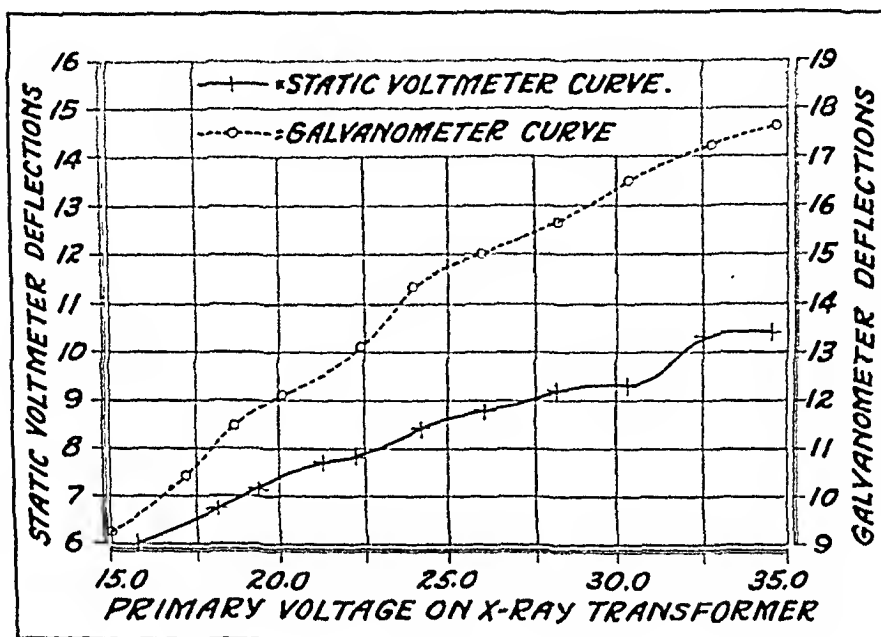


Fig. 2.

be proportional to the ionization current, therefore the deflection of the needle will be proportional to the ionization current.

The current through the instrument is given by the equation

$$I = \frac{V}{R_s}$$

where  $R_s$  is the resistance of the shunt across the instrument, and  $V$  is the voltage.

*Experimental arrangement.*—In the wiring diagram shown in Figure 1, we have represented the usual Duane arrangement of battery  $B$ , connecting through a shielded lead  $L$  to the ionization chamber  $I$ . The ionization current ordinarily passes through another shielded lead  $L_2$  to the galvanometer  $G$ , and so completes the circuit to the battery. This will occur above when the

the chamber when X-rays are passing. The current through  $R_4$  is returned to the battery without passing through the galvanometer, and so need not be considered. The leakage current  $i_1$  through  $R_1$  combines with the ionization current  $i$  through  $R$  and passes toward the galvanometer;  $i$  flows only when X-rays are passing, whereas  $i_1$  flows at all times. This makes it possible to measure  $i_1$ , as it is the only current flowing through the galvanometer when the X-rays are off. As  $R_1$  is usually extremely large because of the care taken to insulate the ionization chamber,  $i_1$  is so small in a well designed and constructed instrument that it cannot be measured even by the high sensitivity galvanometer, and does not introduce any appreciable error. The current passing along the lead



toward the galvanometer will therefore be only that due to ionization. Some of this ( $i_2$ ) may, however, escape through the insulation of the lead and so return to the battery, avoiding the galvanometer. Since

portion will remain the same over long periods of time.

The measurement of the proportion may be made in either one of two ways. In the first, the ionization current is sent through

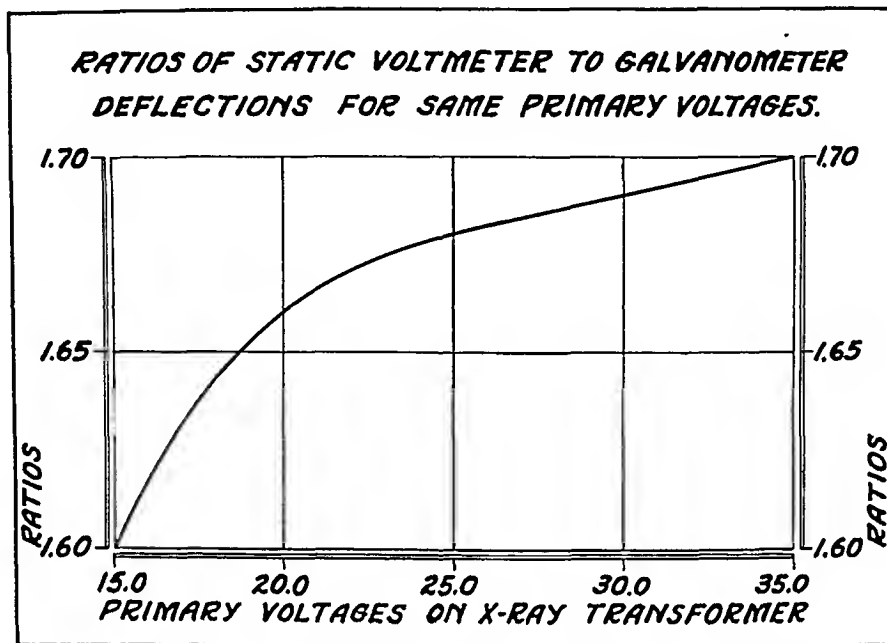


Fig. 3.

the path through G has only about one-millionth of the resistance of  $R_2$ ,  $i_2$  will at best be only one-millionth part of the ionization current, the remainder passing through G. We can therefore safely state that the current measured by the galvanometer is the actual ionization current due to the passage of X-rays through the chamber.

By opening switch  $S_1$  and closing  $S_2$ , we can substitute the electrostatic voltmeter for the galvanometer. This alters the situation somewhat, as the voltmeter has a very high resistance,  $R_3$ , comparable to that of  $R_2$ . An appreciable fraction of the ionization current will therefore pass through  $R_2$  and escape measurement. It will be necessary to know in what proportion the current divides, and to be sure that the resistance  $R_2$  and  $R_3$  remain constant, so that this pro-

portion will remain the same over long periods of time. The static voltmeter is then switched in, causing the current to divide. The resistance  $R_3$  is known and since the meter measures the voltage  $V$  caused by  $i_3$  passing through  $R_3$ ,  $i_3$  may be calculated from the relation

$$i_3 = \frac{V}{R_3}$$

$i_2$  can then be found, for

$$i_2 = i - i_3$$

and

$$R_2 = \frac{V}{i_2}$$

Now  $i_1$  will be smaller than when the galvanometer was in use, as the voltage across  $R_1$  is less. We can, therefore, still neglect

it. From these considerations, it follows that

$$i = \frac{(R_2 - R_3) V}{(R_2 R_3)}$$

The assumption has been made that the voltage across the ionization chamber is sufficient to produce saturation. For the particular chamber used, this value is 6 volts. The voltage across the chamber is the voltage of the battery (45) minus the reading of the voltmeter. The latter can consequently be as much as 39 volts and still satisfy this condition. In no case did it exceed 12 volts.

The second method is to measure  $R_2$  by some one of the standard physical methods. It may then be used in the expression above with  $R_3$  and the reading of the voltmeter  $V$ , to determine the current  $i$ .

It can be seen from the expression above that if  $R_2$  and  $R_3$  remain constant, the ionization current will be proportional to the reading of the voltmeter. In order to test this conclusion, we have measured  $i$  by means of a galvanometer and also by the

static voltmeter, using the circuit described above. The readings of the two instruments have been plotted below (Fig. 2) for a number of different X-ray intensities. The ratio of the readings should be constant, and has been plotted in Figure 3.

It is apparent that the ratio is approximately constant. This is in spite of the fact that the installation upon which this test was made was designed to be used with a galvanometer, and the electrostatic voltmeter was not operating under the most favorable conditions. Improvements are being made which will increase the sensitivity of the meter and better adapt it to this use.

#### CONCLUSIONS

The electrostatic voltmeter is capable of measuring currents ( $10^{-9}$  amperes, or one-billionth of an ampere) which usually require a high sensitivity galvanometer. It is, therefore, suitable for measuring ionization currents from the Duane type of ionization chamber, and it makes possible the construction of a rugged, direct-reading iontoquantimeter of high sensitivity.

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# A FURTHER REPORT ON THE X-RAY TREATMENT OF MENORRHAGIA OF THE MENOPAUSE AND UTERINE FIBROIDS<sup>1</sup>

ANALYSIS OF ONE HUNDRED CONSECUTIVE CASES

By L. J. CARTER, M.D., The Bigelow Clinic, BRANDON, MANITOBA, CANADA

**I**N a former paper the writer detailed twenty-three case reports of uterine fibroids and menorrhagias of the menopause treated by X-ray, with 100 per cent cures. At the present time I wish to present a series of one hundred consecutive cases, and indicate the results achieved. For the sake of brevity individual case reports are not appended. Suffice it to say that the cases are not selected ones, but the series reported comprises every case treated during the period of time covered.

The conditions treated embraced all degrees of severity, but were mostly of the aggravated type. Many of the patients were brought to the treatment room on a stretcher. Many evidenced a degree of anemia requiring blood transfusions. Many showed a variety of pelvic inflammatory complications.

In presenting this larger series the writer has but two thoughts to emphasize:

1. The X-ray treatment of uterine hemorrhage and uterine fibroid is good for 100 per cent cure, providing that a careful examination has ruled out the possibility of malignancy. This, of course, is a conclusion which has been reached by many X-ray therapists, and for it the writer claims no special originality. He would, however, add his statistics to those furnished by many other workers, and thus accumulate the published evidence that this method of treatment has a sound and proven basis.

2. The real reason, however, for this communication, at the present time, is to emphasize the conviction that in these con-

ditions it is possible to effect a cure with much less total X-ray dosage than is usually employed.

From the standpoint of technic the writer still adheres to 125 kilovolts, a 10-inch focal skin distance, and a filter of 6 mm. aluminum, with sole leather. The total dosage is spread over a period of three series, with a month's interval between the series. But, whereas, twelve years ago we kept the patient a week for each series, and delivered the treatment through sixteen ports of entry—eight anterior and eight posterior—we now keep the patient only two or three days for each series, and deliver the treatment in from four to six sittings through three ports of entry—all anterior. Formerly the ports of entry were small, and overlapping was avoided. Now we use larger ports and allow them to overlap.

The total dosage delivered is very much reduced. In the former report (1923), the technic for each series was given as 5 ma., 10 minutes through each port, 12 ports of entry. This made 600 milliamperes-minutes for each series, or 1,800 for the entire treatment. Recently we have been using 5 ma., 10 minutes through each of three anterior ports and repeating this on a subsequent day. This makes 300 milliamperes-minutes for each series, or 900 for the entire treatment. The total dosage has been cut in two, with no sacrifice of results.

So interesting did the results appear that we are now experimenting with a further cutting down of total dosage from 900 milliamperes-minutes to 600. Instead of giving six treatments of 10 minutes each for each series, we are giving only four:—ten minutes

<sup>1</sup>Read before the Radiological Society of North America at the Fifteenth Annual Meeting, at Toronto, Ont., Canada, Dec. 2-6, 1929.

through each lateral port, and 20 minutes through the central one. The results have been encouraging. Only very occasionally has there arisen the necessity of going beyond the three series of treatments to secure arrest of the hemorrhage. We expect this technic will constitute a future working basis. With this as a minimum, the treatment in each particular case will be modified according to the response obtained in the individual patient.

The chief factor in determining whether a greater or less dosage shall be required will be the presence or absence of fibroid changes in the uterus. The presence of fibroid changes is always a factor requiring the increased dosage.

In this series of one hundred cases treated, the average number of series for the menorrhagias not associated with fibroid changes was two and a half. In cases in which the hemorrhage was associated with fibroid change, the average was three series, while in the cases treated for the reduction of uterine fibroids alone, the average was five series.

The one hundred cases of the series are classified as follows: Hemorrhage of the menopause without demonstrable fibroid changes in the uterus (62 cases); hemorrhage associated with fibroid changes (19 cases); uterine fibroid without hemorrhage (12 cases); hemorrhage associated with inflammatory lesions in other pelvic organs (4 cases). Three proved later to be malignant.

The results may be tabulated as follows: The three malignant cases required subsequent radium and surgery, and the patients are alive and well at the present date. From fifteen cases no report has been obtainable. The remainder, without exception, remain cured, after intervals of from one to twelve years.

The contra-indications to the use of the X-ray in these conditions are few and defi-

nite. Associated pelvic inflammatory conditions may constitute a contra-indication to the intra-uterine use of radium, especially following a curettement. They do not constitute such a contra-indication when the X-ray is the therapeutic medium employed, but, rather, the opposite. The striking results secured in the X-ray treatment of boils and carbuncles find an analogy in the magic disappearance of pelvic inflammations after a course of X-ray therapy.

The presence of malignancy does form a contra-indication. Where there is any suspicion aroused, such as by the character and odor of the discharge, or the suggestion of degenerative uterine changes is elicited on bimanual examination, a diagnostic curettage should be done and the detritus subjected to pathological examination. In spite of careful and painstaking examination, malignancy may not evidence itself until later, as in the three malignant cases appearing in this series.

Another contra-indication to the use of the X-ray is the presence of urgent pressure symptoms from a large or incarcerated fibroid tumor. Surgery is then the treatment of choice.

Excessive size of a fibroid tumor may be a contra-indication to the use of the X-ray on account of the prolongation of treatment necessary, and the profound intoxication often associated with absorption of the degenerative products released during the retrogression of such a large tumor. I prefer surgery in these large fibroid tumors.

Another contra-indication to X-ray treatment is the subserous pedunculated fibroid. This is better removed surgically, especially if the pedicle permits of torsion.

I have had no experience with the submucous polypoid type of fibroid as a cause of subsequent recurring hemorrhage, after an apparent cure. If it does not yield promptly to subsequent X-ray treatment, surgery should be employed.

The X-ray treatment of uterine hemorrhage in women during the productive period should, in the writer's opinion, be generally avoided. Two such cases appear in this series. One received a complete series (one-third of the usual dosage) and another but half a series (one-sixth of the usual dosage). In each case the hemorrhage was controlled, and subsequent menstruations were normal.

In spite of these successes I have generally discouraged the reference of women in the child-bearing period for radiotherapy, fearing the effect on possible future offspring. There is experimental evidence indicating that the germ cell may be so modified by irradiation as to establish hereditary abnormalities, not in the offspring, but in descendants one or more generations remote.

Regarding the choice of radiotherapeutic methods, between the X-ray and radium, we believe this should be a matter of personal preference, depending on one's experience with the method employed, or his equipment. The desired results can be secured whether one uses the X-ray or radium. Personally, I prefer the X-ray, since, with the moderate dosage now employed, the treat-

ment becomes a simple office procedure, not involving much loss of time or much discomfort to the patient. I prefer to reserve radium treatment for the malignant uterine and cervical conditions, which require hospitalization and operating room technic.

The *modus operandi* of the X-ray in the arrest of uterine hemorrhage and the reduction of uterine fibroids is generally regarded as the combination of a number of actions. Radiation is essentially a destructive process, involving the disappearance of the immature, rapidly growing, fibroid cell, and its replacement by connective tissue. The blood supply of the growing tumor is cut off, and the engorgement of the bleeding uterus is reduced by the production of an endarteritis. The Graafian follicle is either destroyed or undergoes cystic degeneration. The corpus luteum and the internal secretion of the ovary are evidently not destroyed. By the moderated dosage now in use the internal function of the ovary is not depressed to any greater extent than in the normal climacteric, for the radiotherapeutic menopause, as I have observed it following this series of treatments, has not been more stormy than the normal.

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# DEEP X-RAY TREATMENT OF CHRONIC GONORRHEAL INFECTION IN THE FEMALE<sup>1</sup>

By C. M. HENRY, M.D., C.M., F.A.C.S., REGINA, SASK., CANADA

CHRONIC gonorrheal infections have been a menace to civilization ever since ancient times; and, although medical science has done much to alleviate suffering in the great majority of cases, there are still a few of the most chronic gonorrheal infections that fail to respond to general medical treatment, as it is practised to-day.

Years before the Great War, and more especially since that event, governments, states, and provinces formed dispensaries for treatment, control, and supervision of patients afflicted with gonorrhea.

In Saskatchewan, since the Great War, public dispensaries have been opened and operated under the control and supervision of the Health Department of the Province. These dispensaries are manned by specially trained medical officers, and well selected laboratory assistants, but in the course of time the dispensaries gradually have accumulated a group of cases the smears of which remained positive for diplococci, in spite of prolonged and intensive medical treatment.

The Health Department, deciding not to discharge these patients until a cure was effected, realized that some remedy must be found, or these patients would become public charges on the Province for life, also menaces to the public as carriers of infection.

In the year 1924, the Health Department learned that Dr. H. E. Young, of British Columbia, had had encouraging results by using deep X-ray treatment on several cases of chronic gonorrheal infection. On the strength of Dr. Young's report, I was in-

structed by the Provincial Health Department of Saskatchewan to undertake the treatment of six female cases. The case reports pertaining to their physical conditions before and after treatment are appended to this paper.

Since I treated these, ten private patients have received similar treatment, with like results.

The six cases selected for deep X-ray therapy were all suffering from chronic gonorrhea of long standing, the infection having been present for from two to nine years.

Each patient had received intensive medical treatment, consisting of iodine, saline, soda, or lysol douches, all depending on the condition of the cervix; silver nitrate, or glycerin, and carbolic applications to the cervix, twice weekly, and sitz-baths twice weekly. Smears taken showed in every case the presence of pus and gonococci. Discharge in all the cases was of the same kind, being thick, profuse, and of a greenish-yellow color. Two of the patients complained of pains over the region of the tubes, and one patient had had a previous salpingectomy. All had edema and erosions of the cervix.

The X-ray technic was the same for each patient, regardless of age, physical condition, physique, or duration of the infection. Treatment was given through two portals of entry—one anterior pelvic, and one posterior pelvic, namely: F.S.D., 50 cm., K.V., 200 peak; filtration,  $\frac{3}{4}$  mm. Cu and 1 mm. Al; 5 ma.; time, 60 min. for each port of entry. Treatments were given on alternate days.

The results in all cases, both dispensary and private patients, were practically the same. The erosions disappeared from the cervix; the discharge became very thin and

<sup>1</sup>Read before the Radiological Society of North America at the Fifteenth Annual Meeting, at Toronto, Canada, December 2-6, 1929.

slight, and there followed a marked improvement in general health.

Smears taken over a period of four months after treatments failed to reveal the presence of gonococci in five of the six patients (the positive cases having had only one smear examined).

One patient menstruated three weeks following treatment; two, six months following treatment; one, seven months following treatment, and two patients did not menstruate until one year following treatment. These were the youngest of the group.

#### CASE REPORTS

Reports of each of the six cases are as follows:

Case 1. Age 21. This patient was admitted to the dispensary in April, 1920, for treatment, suffering with chronic gonorrhea. History of infection three years previous to her admission, but she had been having treatment and was supposed to be cured. She complained of pain over the region of the Fallopian tubes, intermittently, edema and erosion of the cervix, and profuse discharge of a greenish-yellow color. Some improvement was noted at times, but the symptoms recurred after continuous medical treatment for four and one-half years, the treatment consisting of vaginal irrigations of iodine, saline, soda, and lysol douches, with sitz-baths twice weekly.

Smear for gonococci taken August 16, 1924, was positive.

*General physical condition:* Thin, pale girl, with lowered vitality.

Deep X-ray treatment was given on August 20 and 22, 1924. Smears taken three months after treatment from the vagina, urethra, and cervix showed an odd pus cell, but no gonococci. The cervix then appeared normal, with no erosion. Discharge was very thin and slight. There was a marked general improvement in health. The patient menstruated three weeks after treatment.

Case 2. Age 21. Admitted to the dispensary on December 18, 1923. She had given birth to a baby at 12 years of age, and infection was supposed to date from that time. Vaginal examination showed a thick, greenish-yellow discharge, and erosion of the cervix. Smear was positive for diplococci. Medical treatments were given as in Case 1, but the smear remained positive. The general health was fair.

Deep X-ray treatment was given August 24th and 27th, and smear examinations were made on the following dates: *September 3rd*, from cervix, urethra, and vagina; pus present, and extra-cellular diplococci; *October 14th*, from cervix, urethra, and vagina; pus and gonococci present; *November 4th* (or 38 days after treatment), from cervix and vagina; pus present, but no gonococci; from vagina, no pus nor gonococci; *November 25th*, from cervix, urethra, and vagina; pus present, but no gonococci found; *December 2nd*, from urethra and vagina; no pus nor gonococci present; from cervix, pus; no gonococci; *examinations from January 13th to February 2nd*, from cervix, urethra, and vagina; no pus nor gonococci found.

This patient was negative for gonococci 38 days after X-ray treatment, and remained negative. She received regular treatments, following deep therapy, of vaginal douches and applications of silver nitrate, 20 per cent, to the cervix and urethra. No vaginal discharge, and the patient reported that her health was improved 100 per cent since treatment. She menstruated seven months following X-ray therapy.

Case 3. Age 23. This patient was admitted to the dispensary on November 13, 1923. She had contracted gonorrhea one year previously, and during those twelve months had been receiving treatment.

Vaginal examination revealed edema and erosion of the cervix, with profuse, greenish-yellow discharge. A smear was positive

for gonococci. The general health was good.

This patient received the usual medical treatment, as given to the others, but the smears remained positive, and the discharge persisted.

Deep X-ray treatment, over the prescribed areas, was given on August 20 and 22, 1924, with the result that the cervix appeared normal, there was no erosion, and the discharge was very thin and scanty. The patient's general health improved. Smears taken from the cervix, urethra, and vagina showed a small amount of pus, but no gonococci. The patient's menstrual cycle was not regular for six months.

Case 4. Age 19. Examination made on July 31, 1922, revealed a large amount of purulent discharge, edema, and erosion of the cervix. Smears showed pus and extracellular diplococci. The general health was fair.

On December 2, 1922, the patient had a double salpingectomy. Following this, she received routine treatment, but the discharge persisted, with no improvement until deep X-ray treatment was given August 20 and 22, 1924. Following that, the discharge became slight, and the cervix normal. Smears taken on October 18, from the cervix, urethra, and vagina, showed an odd pus cell, but no gonococci: negative in 57 days. December 20, smears from the cervix and vagina showed an odd pus cell, but no gonococci; from the urethra, no pus nor gonococci. The patient did not menstruate for eight months.

Case 5. Age 14. This patient was admitted to the dispensary in September, 1923, the innocent victim of a carnal knowledge case. Examination revealed the same condition as found in the former cases, which resisted routine treatment. Following X-ray treatment (given on August 20 and 22, 1924), smear taken 18 days after treatment (on September 9) was negative for

gonococci, but the patient did not menstruate for nearly a year.

Case 6. Age 28. This patient was admitted to the dispensary on August 20, 1923. She had been receiving treatment for two years. She complained of pain in the region of the tubes and ovaries. Smears taken were positive for gonococci, and the usual medical treatment was given, but the condition persisted.

Deep X-ray treatment was given on September 4 and 6, 1924. The discharge became very thin, and whitish in color. The cervix appeared normal and the general health was much improved. Smears taken on September 25, three weeks following therapy, were negative for gonococci, and continued negative by examinations made from time to time, until February 3, 1925, when the patient was discharged. Menstruation returned in six months.

#### SUMMARY OF THE CASES

Six cases of gonorrheal infection of the vagina, urethra, and cervix, treated by deep X-ray.

Ages of group, from 14 to 28 years, the average being 21 years.

Negative smears within three months, following radiation treatment.

One patient became pregnant three months following treatment.

Two patients did not menstruate for one year; they were the two youngest of the group.

Four patients menstruated before eight months.

All patients showed marked general improvement in health.

Three patients have married and become respectable members of their community, but have no children.

Two patients did not report after one year, and are not living in the Province now.

I wish to acknowledge my indebtedness to the Saskatchewan Public Health Depart-



ment for kindness in granting me the use of the records of the six cases reported.

#### DISCUSSION

DR. H. E. SCHAEF (London, Ont., Canada): This report is most interesting and is along the same line as the cleaning up of diphtheria carriers' tonsils, which was reported by Dr. Hickey some few years ago. You will remember he cleaned up diphtheria carriers which otherwise could not be cleaned up. In that connection it has always been understood that the X-ray is not a disinfectant—that is, that it will not destroy a micro-organism.

Some few years ago at the University with which I am associated, they were working on liver extract, and were trying to figure out a method of sterilizing the mixture without boiling it or adding chemical agents which might interfere with the action of the extract. They tried submitting it to radiation, and the strange part of it was that, while they always got a very good culture on agar plates from the extract, after radiating it a very short time in a shallow dish, it was negative. Ever since then I have been quite dubious as to whether or not our former opinion was correct. How much we can use radiation for that purpose is a question.

I would like to ask Dr. Henry if in these cases the patency of the tubes was checked up. True, in several cases pregnancy followed, so that the tubes must have functioned, still it would be interesting to know in how many of the cases the tubes functioned after treatment. In gonorrheal infections the tubes are usually destroyed anyway, so that it really does not matter so very much. Still it would be worth while, if one could get some record on that point, and I am just wondering if the cases had been checked up with lipiodol, or if operation for some reason or other might have followed and the tubes sectioned.

DR. JOSEPH FREEDMANN (New York): A little over two weeks ago Dr. Frank J. Horn, of New York, referred a patient to me, a young woman about thirty years of age, who for many years had suffered from gonorrheal salpingitis. She had had several operations. There was a very marked discharge, which was practically continuous, and which no medication had succeeded in helping. The patient was referred to me for a partial castration dose. The referring physician told me the object of the treatment was to stop the functioning of the ovaries and to decrease pelvic congestion. He had read in the German literature that by this method of treatment very excellent results had been obtained and the discharge entirely eliminated, with return of normal menstruation.

On account of this young woman complaining of pelvic pains, I did not give her the treatment in just one or two doses, but gave it over a period of six treatments, that is, one every other day.

Listening to Dr. Henry's paper, I was extremely interested to hear what we can do with patients of this type.

DR. F. C. CHRISTENSEN (Racine, Wis.): This is a most interesting subject, indeed. It opens up a new field in radiotherapy and therapeutics—a field, however, in which we have to be careful.

Dr. H. J. Baggs, of Memorial Hospital, New York City, has for some years been studying the effects of radiation upon the offspring of animals. Many deformities result, such as single kidney, one eye, club foot, etc., from radiation.

Four years ago, while in Vienna, I was visiting with Dr. Wiebel and saw him do a vaginal section on a woman five months pregnant. The patient had had pulmonary tuberculosis and was suffering with menorrhagia for which she had been given X-ray treatment. She ceased to menstruate and

it was thought to be the result of the X-ray treatment, but later she was found to be pregnant. On account of the X-ray treatment they feared that there would be some deformity in the child, hence the operation. The fetus appeared normal, but they were going to make a careful sectional study, the result of which I did not learn. That shows how fearful they are of X-ray treatment in cases of pregnancy.

I should certainly like to follow up further reports on the cases mentioned in this paper. Three of the six cases reported are probably sterile, and that is a matter one should consider before deciding upon X-ray treatment.

I am wondering whether it is necessary to give such heavy treatment. I use a much lower voltage, less filter, and shorter time in sterilization and find it efficient.

Here is another problem: Does the inflammatory reaction increase the radioreistance of the ovaries?

DR. G. E. RICHARDS (Toronto, Ont., Canada): I think it is about six years since radiologists in Victoria Memorial Hospital, Victoria, B. C., published a similar report. Have you made any reference to that? In this report there were a number of cases of this disease with good results following treatment, and I have in a corresponding way had some good results. The only objection that has ever been made to the method by gynecologists with whom I have discussed this question is the necessity of giving a dose which involves permanent sterilization of the patient. In Dr. Henry's paper these were nearly all young women. Some sufferers from this disease, of course,

are mentally defective, and from that standpoint it is desirable that there should be sterilization. Others are not, and in that case it becomes a real problem whether or not such a dose should be given as will result in permanent sterilization. If that is going to result from the normal processes of the disease, by the salpingitis and the closure of the tubes, of course we might as well do it as let Nature do it.

I was interested in the last speaker's suggestion, that it may be possible to accomplish the same result without permanent sterilization. Apparently that is possible, in view of Dr. Henry's experience. Certainly it is a field which offers distinct possibilities, and I think we should all be prepared to follow it up.

DR. HENRY (closing): Yes, I made reference to Dr. Young's report.

I might say that all these cases were, as you know, chronic gonorrheal infections of from two to nine years' standing. The supposition was that they were sterile and that their tubes were closed, but it proved otherwise in regard to the one who became pregnant within three months after the treatment. The three others who were married have no children, but they have all menstruated regularly following the first year.

It would be most interesting indeed to find out whether or not the three who are married are sterile or not, but that is a rather delicate and difficult thing to undertake. Although we have thought of that, it is rather hard to get the former patients to submit to an examination of that kind. We may find out some more facts later on.

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# THE EFFECT OF X-RAYS ON THE THYROID AND PARATHYROID GLANDS

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**E**VEN though X-rays have been used rather extensively in the clinical treatment of hyperthyroidism, only a small amount of experimental work has been done on the effect of radium and X-rays on the thyroid and parathyroid glands.

Krause and Ziegler (1) exposed the thyroids of several common laboratory animals to X-rays and failed to detect specific changes. They killed their animals either immediately or only 72 hours after exposure, which explains in part the negative nature of their results. Rave (2), using the comparatively large dosage of from 12 to 36 Kienböck units, observed no histological changes. He killed his rabbits in from 5 to 8 days, which we believe was too soon to obtain definite effects. Rave also, in 1911, treated the thyroid of several human cases with X-rays and reported good clinical effects, but on removing the treated thyroid gland found only slight changes. The lymphoid tissue of the gland, as might be expected, was decreased; the colloid struma was unaffected. He stated that the effect of X-rays on pathological thyroid tissue was not settled. Pfeiffer (3) and Fiorentini and Louraschi (4) failed to obtain changes in the thyroid in dogs. Bower and Clark (5) implanted steel radium needles containing 12.5 mg. of radium for from 2 to 13½ hours into the thyroid gland of dogs. They concluded that the normal thyroid of the dog is highly resistant to the action of radium, no changes being demonstrable in the parathyroids. McCord and Marinus (6) exposed tadpoles to X-rays and found that the exposure made them more susceptible to

thyroid feeding, which denotes apparently a stimulation with the doses used. Coulaud (9) found that very large doses of X-rays were necessary to affect the normal thyroids of rabbits, from 35 to 50 H being required to cause a slight decrease in the colloid and from 80 to 100 H being required to cause a definite decrease in colloid. We have been unable to find any reports in the recent clinical literature on the effect of X-rays on the histology of the human thyroid, save that the size of malignant tumors of the thyroid is decreased and the metastases are more difficult to influence than the primary tumor (7).

The experimental literature at hand indicates that *normal* thyroid tissue is resistant to X-ray, while the clinical literature tells us practically nothing about the effect of X-rays on the hyperplastic thyroid, but does indicate that in some way X-ray treatment benefits temporarily some 60 per cent of the patients afflicted with hyperthyroidism. We should keep in mind the possibility that the normal thyroid may be more resistant to X-rays than the hyperplastic thyroid, since it is well known that embryonic cells are generally more sensitive to X-rays than adult cells.

In this paper we will report the effect of a dose of X-rays used clinically on the histology of the thyroid and parathyroids and on the blood calcium of normal dogs. The dose used has yielded beneficial clinical effects in some patients with hyperthyroidism.

## METHODS

*Dosage.*—The dosage used in these experiments was that used in the clinical

treatment of hyperthyroidism by Dr. B. H. Orndoff (North Chicago Hospital, Chicago). For our equipment the dosage was as follows: Ma., 4; sphere gap, 130; peak, 177; filter, 0.25 mm. Cu plus 1 mm. Al; portal  $5 \times 8$  cm.; distance, 50 cm.; time, 55 min.; yielding 385 r units.

The output of Dr. Orndoff's equipment was measured with the radiometer and then our equipment was set for the same output, also with the radiometer. This dosage, repeated three times on successive days, results in a second or third degree burn in man, which is known to be correct. Dr. Orndoff usually treats his patients with the above dosage three or four times, the doses being 21 days apart, which is designated as one series.

Since the evidence in the literature indicates that the dog's normal thyroid is quite resistant to radiant energy, we decided to give four doses, from 7 to 14 days apart, which we called a series. So the term "series," as we use it, means the above dose of X-rays given four times, 7 to 14 days apart.

The blood calcium was determined at intervals throughout the experiment.

Four different types of experiments were planned. In *Experiment I*, three series, four doses each, were given, the time between the first and second series being four months, and between the second and third being one month, the dogs being observed for nine months. In *Experiment II*, one series was given and the thyroid examined at four months after completion of the series. In *Experiment III*, two series were given three months apart. Two months later one thyroid was removed, and then, four months later, the other thyroid was removed. In *Experiment IV*, three series were given, the time between Series 1 and Series 2 being one month and between Series 2 and Series 3 being three months. One thyroid lobe was removed between the second

and third series. These different experiments were planned with the idea that different effects might occur. Two dogs were used in each series.

## RESULTS

*Changes in Parathyroids.*—Table I shows the average blood calcium values for the various dogs. It is to be noted that only two of the seven dogs showed a decrease after the first series, a decrease that is quite small. All dogs showed a decrease after the second series. The amount of the decrease was not sufficient to cause disturbances due to low blood calcium, the greatest decrease being 2.4 mg.—from a high level of from 13.0 to 10.6 milligrams. A significant change in blood calcium occurred in Dog 4, which received excessive radiation to the point of ulceration. In this dog the parathyroid was histologically hyperplastic but contained an abnormal amount of connective tissue stroma and its capsule was much thickened. Dog 8 also showed a significant decrease in blood calcium, but it must be kept in mind that he had lost two parathyroids.

The results on blood calcium clearly show that although the X-rays caused a hyperplasia of the parathyroids, the hyperplasia did not result in increased blood calcium; but the blood calcium decreased slightly in spite of the hyperplasia.

The results in Dogs 7 and 8 further show that the X-rays administered prevented compensatory hyperplasia only to a slight degree following removal of two parathyroids. It did prevent some compensatory hyperplasia, since the parathyroids in Dogs 7 and 8 were not as large as those in Dogs 5 and 6, which did not receive the third series. The greater amount of connective tissue in the parathyroids of Dogs 5 and 6 than in Dogs 7 and 8 was probably due to the difference in time since the last X-ray exposure.

*Thyroids.*—Only the histology of the thyroid was studied. All dogs, to start with, had small thyroids. The dogs received a diet of cooked yellow corn meal, bone soup, and baker's whole wheat and white bread.

These results show that the normal thyroid of the dog is highly resistant to X-rays, the only detectable effect being a tendency towards hyperplasia. Thickening of the thyroid capsule occurred only when

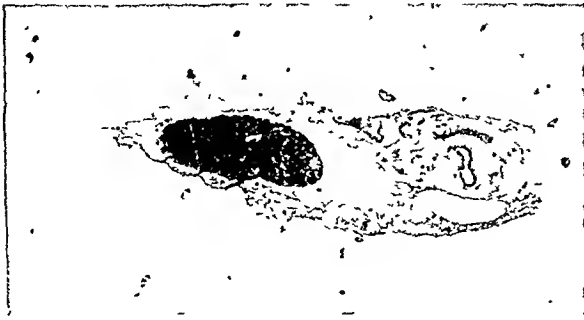


Fig. 1. Showing the normal parathyroid of a dog of average size, magnified 11 times.

Biopsy was not performed before X-ray treatment was instituted because we did not want to introduce changes incident to the operation. But in Dogs 5, 6, 7, and 8 we did have a control picture of the thyroid after two series of X-ray therapy. In this group of dogs the thyroid presented a normal histological appearance after X-ray treatment with the exception of Dog 6. In this dog the thyroid was slightly hyperplastic after the second series, and after the third series it showed greater or unmistakable hyperplasia. So the X-rays produced in this group either no change or a hyperplasia; however, one might expect some compensatory hyperplasia after the removal of one lobe of the thyroid, as was done in these dogs. In Dogs 2 and 4, which suffered skin burns, the capsule of the thyroid was definitely thickened. This did not occur in the other dogs. The gland of Dog 1, which received three series, was hyperplastic. None of the thyroids were grossly larger than normal, and even those which showed hyperplasia histologically were of normal size.

Epilation, or disappearance of the hair, of the exposed neck was present in all dogs.



Fig. 2. Showing one of the hyperplastic parathyroids of Dog 5, measuring  $3 \times 2.8$  mm. after fixation, magnified 11 times.

skin burns occurred, with edema of the neck.

#### PROTOCOLS

*Dog 1.*—Received first series between May 20 and June 11, 1929; second series between Nov. 13 and Dec. 13, 1929; third series between Jan. 20 and Feb. 24, 1930; killed, April 2, 1930.

*Histology.*—Three series. *Thyroid:* hyperplasia. No increase in connective tissue. *Parathyroid:* epithelial hyperplasia without increase in stroma or blood vessels. The hyperplasia is not as marked as in Dogs 5, 6, 7, and 8.

*Dog 2.*—Same series as Dog 1. During the first dose of Series 1, the distance was 30 cm. instead of 50 cm. for 20 minutes. Killed, April 2, 1930. There was a second degree burn of the neck. The thyroid was grossly edematous.

*Histology.*—Three series (more dosage). *Thyroid:* capsule thickened; hyperplasia. *Parathyroid:* epithelial hyperplasia, with increase in stroma to the point of lobulation.

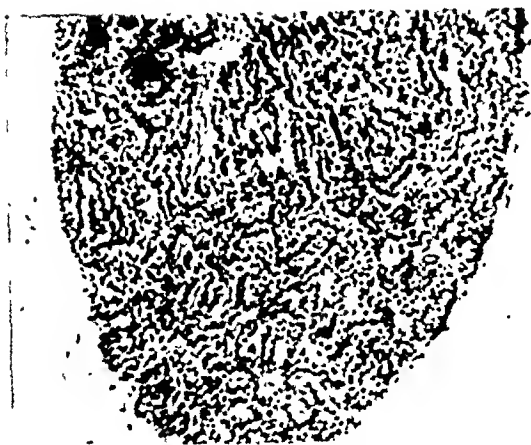


Fig. 3. Showing the microscopic structure of the normal parathyroid of a dog, magnified 165 times.

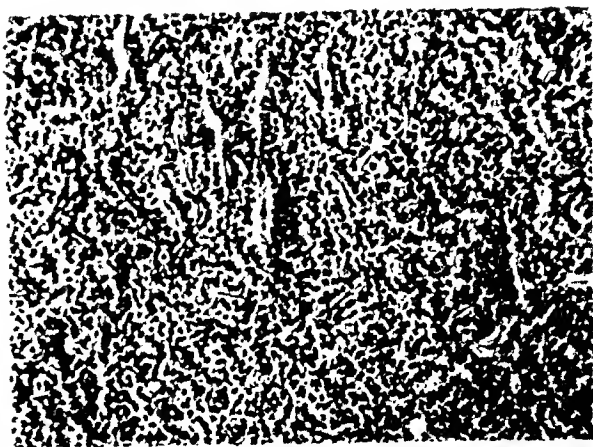


Fig. 4. Showing the microscopic structure of the hyperplastic parathyroid of Dog 5, magnified 165 times. Note the dense epithelial cords. No oxyphilic cells found.

*Dog 3.*—Dog died of distemper five days after third dose of Series 1.

*Histology.*—*Parathyroids:* epithelial cords shrunk and loosened from stroma; some degeneration of cells (probably (?) postmortem change). *Thyroid:* normal.

*Dog 4.*—Received first series between May 29 and June 20, 1929. During second dose of first series the filter was left out for 40 minutes. Died, Oct. 2, 1929. X-ray burn, third degree, of neck. Lobes of the thyroid were very hard or firm and small.

*Histology.*—*Parathyroids:* epithelial cords much shrunk; considerable increase in connective tissue stroma. Greater histological change than in other dogs. Capsule very thick (approximately 1 mm.). *Thyroid:* areas throughout section showing definite hyperplasia. Not much colloid in gland. Questionable increase of connective tissue about blood vessels. Capsule much thickened.

*Dog 5.*—Received first series between June 20 and July 18, 1929; second series between Oct. 16 and Nov. 5, 1929. Right thyroparathyroidectomy, Jan. 11, 1930. Killed, April 2, 1930. Parathyroids appeared to be larger than normal.

*Histology.*—Two series—right thyroparathyroidectomy by operation. *Thyroid:* normal. *Parathyroid:* there is definite hyperplasia but not quite as much as in Dog 6, with a slight increase in connective tissue. Three

series—left thyroid parathyroidectomy. *Thyroid:* normal. *Parathyroid:* marked hyperplasia present. The fixed gland measures  $3 \times 2.8$  millimeters. There is some increase in vascularity, also in connective tissue.

*Dog 6.*—Received first series between June 20 and July 18, 1929; second series between Oct. 16 and Nov. 5, 1929. Right thyroparathyroidectomy, Jan. 11, 1930. Killed, April 2, 1930. Parathyroids appear to be larger than normal.

*Histology.*—Right thyroid parathyroidectomy by operation. Two series. *Thyroid:* slight hyperplasia, little colloid. *Parathyroid:* there is a definite hyperplasia, with an increase in connective tissue.

*Dog 7.*—Received first series between July 17 and Aug. 9, 1929; second series between Sept. 11 and Nov. 1, 1929. Right thyroparathyroidectomy Nov. 8, 1929. Received third series between Dec. 26, 1929, and Jan. 14, 1930. Dog died of distemper Feb. 4, 1930, 20 days after last dose.

*Histology.*—Gross hyperplasia of parathyroids. Two series. Right thyroid parathyroidectomy by operation. Two series. *Thyroid* is normal. *Parathyroid* shows definite hyperplasia, without connective tissue change. Three series. Left thyroparathyroids were only slightly hyperplastic. Thyroid normal in size and normal histologically except for a small area of hyperplasia. Parathyroids were



Fig. 5. Showing the hyperplastic parathyroid of Dog 2, magnified 165 times. Note connective tissue increase. This dog received excessive radiation.

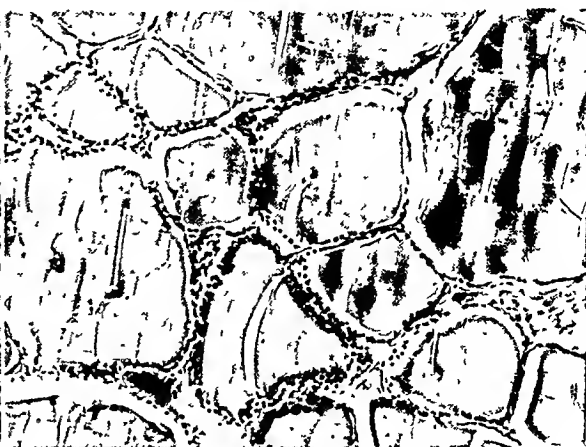


Fig. 6. Showing the thyroid of Dog 7, which is quite normal, magnified 165 times.

larger than normal, but not as large as in Dogs 5 and 6.

*Dog 8.*—Same series as Dog 7. Removed left lobe of thyroid March 15, 1930, two months after last dose.

*Histology.*—Gross hyperplasia of parathyroids. Two series. Right thyroparathyroidectomy by operation. *Thyroid* is normal. *Parathyroid* shows definite hyperplasia (more intensely than in Dog 7). Three series. Left thyroparathyroidectomy (after third series). *Thyroid* is normal. *Parathyroid* is larger in size than that found on the right side. It is definitely hyperplastic and appears to be more vascular. This confirms gross findings. It was not as large as in Dogs 5 and 6.

#### DISCUSSION

It is quite apparent from this work that the normal thyroid of the dog is quite resistant to X-rays and degenerative changes are not caused by the dosage used, which is a dose known to be of some clinical value. It does not follow from this work, which confirms other reports in the literature, that X-rays would have no effect on the hyperplastic thyroid gland of man. According to Warthin (8), the most constant and strik-

ing feature of exophthalmic goiter is the hyperplasia of the primitive lymph nodes of the thyroid. It is well known that lymphoid tissue is especially sensitive to X-rays. Hence, X-rays would at least destroy the lymphoid tissue of the hyperplastic thyroid, if nothing else, and one would be able only with difficulty to detect such an effect in the normal thyroid. So we are still confronted with the problem of the effect of X-rays on the hyperplastic thyroid gland, a problem which we are now investigating in the opossum, in which animal experimental hyperplasia of the thyroid can be easily produced.

It is also quite apparent from the experimental results that X-rays in the dosage used do not cause extensive proliferation of connective tissue. If a burn is produced, or if the treatment is excessive, then there results a thickening of the capsule.

It is interesting that the parathyroids reacted to the X-rays by manifesting hyperplasia. This finding was very definite and unexpected, especially since the blood calcium slowly declined instead of increasing. The only interpretation we can place on this

TABLE I

BLOOD CALCIUM VALUES BEFORE AND AFTER EXPOSURE OF THE THYROID AND PARATHYROID AREA TO X-RAYS

| Dog                | Normal blood Ca. mg. | After 1st series | After 2nd series                 | After 3rd series | After removal of 1 thyroid | Remarks   |
|--------------------|----------------------|------------------|----------------------------------|------------------|----------------------------|---|
| Expt. I            |                      |                  |                                  |                  |                            |   |
| Dog 1              | 11.6                 | 11.7             | 10.6                             | 10.5             |                            |   |
| Dog 2              | 12.5                 | 11.9             | 11.4                             | 11.4             |                            |   |
| Expt. II           |                      |                  |                                  |                  |                            |   |
| Dog 4 <sup>a</sup> | 11.3                 | 11.5             | (9.3 mg. 3 mo. after 1st series) |                  |                            |   |
| Expt. III          |                      |                  |                                  |                  |                            |   |
| Dog 5              | 12.5                 | 11.4             | 10.6                             |                  | 10.4                       |   |
| Dog 6              | 13.0                 | 10.5             | 11.3                             |                  | 10.5                       |   |
| Expt. IV           |                      |                  |                                  |                  |                            | 1 thyroid lobe removed between 2nd and 3rd series |
| Dog 7              | 11.2                 | 11.0             | 10.4                             |                  |                            |   |
| Dog 8              | 11.4                 | 10.6             | 10.3                             |                  | 9.9 <sup>b</sup>           |   |

<sup>a</sup>This dog had more X-ray dosage than the others because of an accident. However, his parathyroid was histologically hyperplastic and contained excessive connective tissue stroma. This dog had four parathyroids.

<sup>b</sup>This dog also showed considerable connective tissue stroma in addition to hyperplasia. He had only two parathyroids, the other two having been removed after the second series.

finding is that hyperplasia of the parathyroids does not necessarily mean hypersecretion.

### SUMMARY

1. The histology of the normal thyroid of the dog was not materially changed by an X-ray dosage known to be of clinical value in some cases of hyperthyroidism. The tendency of the effect was in the direction of hyperplasia.

2. The capsule of the thyroid was thickened only by overdosage which resulted in a skin ulcer.

3. The treatment used caused a definite hyperplasia of the parathyroids. In those dogs in which several months had elapsed after cessation of the treatment an increase in connective tissue of the parathyroids occurred. A gradual slight decrease in blood calcium occurred in spite of the hyperplasia.

4. It is pointed out that these results do not necessarily apply to the hyperplastic thyroid of Graves' disease, which is a different problem. The results indicate that the clin-



Fig. 7. Showing the hyperplastic thyroid of Dog 2, magnified 165 times. Note increased thickness of capsule due to excessive radiation.

ical dosage used in the treatment of hyperthyroidism will not injure the parathyroids.

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Roentgen Examination in Technical Fields. Kantner and A. Herr. *Fortschr. a. d. Geb. d. Röntgenstr.*, June, 1930, XLI, 873.

The importance, the educational value, the methods, and results of technical roentgen examinations in industry and also their costs are reported. When not only the finished products are radiated but also raw material and semi-finished pieces, one may save considerably by early elimination of faulty material before the completion of processes of manufac-

ture. Repeated examination may show the engineer the causes of faults.

X-rays are used for examination of material, investigation of structure (by obtaining interference effects similar to spectra of crystals), and chemical analysis (by analysis of absorption and emission of characteristic radiation). The latter, so far, is entirely in its experimental stage, but the former two have gained considerable importance. The paper is well illustrated and worth while reading in detail.

HANS A. JARRE, M.D.

# CASE REPORTS

## TUMOR INVOLVING LYMPHOID TISSUE

### CASE REPORT

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Stimulated by the article entitled "Lymphoblastoma Involving the Stomach—Roentgenologically Considered," by Howard E. Ruggles, M.D., and Robert S. Stone, M.D., in *California and Western Medicine*, July, 1930, the following case is reported.

The patient, A. V. P., aged 42, an optician, was admitted August 25, 1929, to the Syracuse University Hospital of the Good Shepherd, and gave the following history: Had never had any illness from childhood until December, 1926, when he was taken with a hard cold in the head and chest. Was ill about six weeks. In December, 1927, his left ear drum ruptured, followed by a discharge of two weeks' duration. His best weight had been 170 pounds, in December, 1926; his average weight was 150 pounds. Patient had had "grippe" a year and a half before the present examination and a cold of a month's duration, during which time he coughed and expectorated some thick mucus, with no fever or pain during the cold. During the "grippe" attack he had slight fever, sinus trouble, an ear abscess, no nausea nor vomiting. The fever was not high, but fluctuated. He had profuse perspiration; no hemoptysis.

### PHYSICAL EXAMINATION

Physical examination by Dr. Ellery Allen showed blood pressure 95/55.

*Skin:* Slightly pale; no eruption.

*Head:* No sinus tenderness.



Fig. 1. Radiograph of stomach.

*Eyes:* React to light and accommodation; no nystagmus, ocular palsies, lid lag, or exophthalmia.

*Ears:* No mastoid tenderness. Left ear drum ruptured. No discharge.

*Nose:* Septum slightly deviated to left.

*Mouth:* Several missing teeth. Mucous membrane slightly pale. Tonsils considerably enlarged and cryptic; not acutely affected.

*Neck:* Adenopathy considerable; anterior and posterior cervical glands enlarged but not tender.

*Chest:* Expansion good and no dullness, râles, abnormal breath sounds, nor fremitus changes. Heart not enlarged; rate, 80; sounds of fairly good quality; no arrhythmia, thrill, nor murmurs.

*Abdomen:* Rather tense and has a "doughy" feeling. No spasm, rigidity, definite tenderness. Some distention is present.

Can make out no fluid wave, but there are places in the abdomen where fluid seems to be directly under the examining finger and its displacement can be heard. The spleen is easily palpable and appears to be considerably enlarged, firm, and non-tender. The

#### LABORATORY FINDINGS

*Wassermann.* Negative.

*Examination for typhoid:* Blood, negative; no organisms of the typhoid, paratyphoid, nor dysentery groups isolated in feces.

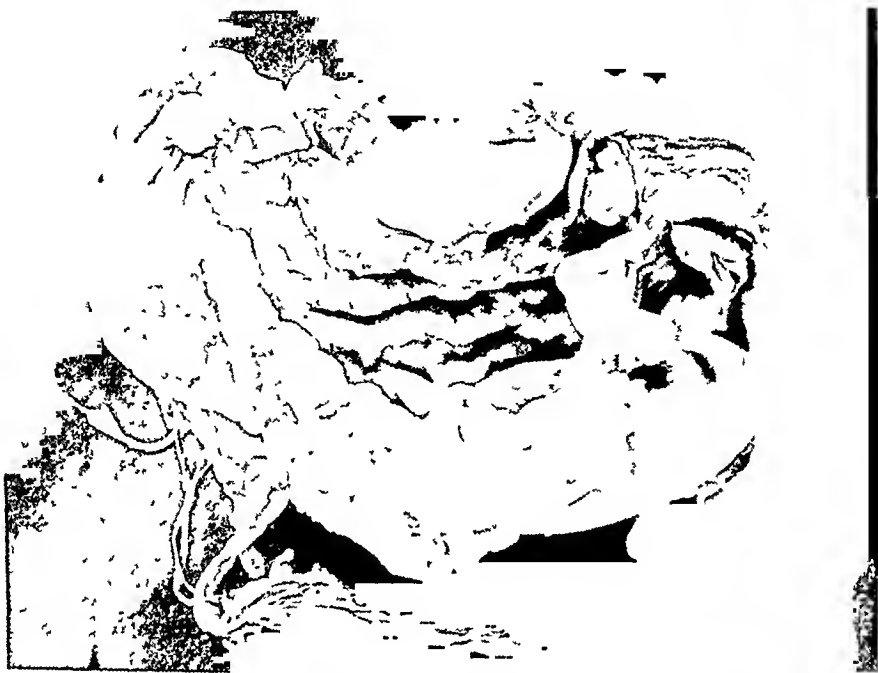


Fig 2 Gross specimen of stomach opened

liver edge can be felt—smooth and firm, non-tender. Just above the umbilicus can be felt a small, firm, irregularly shaped mass the size of a marble. Deep in the right upper quadrant can be felt two or three of these nodular, non-tender masses, all in a group. I doubt if fluid is present in the peritoneal cavity, unless it be in small, walled-off spaces. No costovertebral tenderness.

*Extremities.* Deep reflexes are active. No edema or clubbing.

*Bones and joints.* Essentially negative.

*Glands.* Cervical, axillary, inguinal, and epitrochlear glands are enlarged and palpable; non-tender.

*Rectal:* Prostate not enlarged nor tender. No masses felt. A few small external hemorrhoids.

On August 29, 1928, an epitrochlear gland, left, was removed.

*Clinical diagnosis:* Tuberculosis or Hodgkin's disease.

*Pathological diagnosis by Dr. H. G. Weiskotten:* Lymphosarcoma, possibly of type of aleukemic leukemia.

Left axillary glands removed September 6, 1928, questionable for cancer.

*Pathological diagnosis by Dr. H. G. Weiskotten:* Lymphosarcoma, possibly of type of aleukemic leukemia.

*Proctoscopic examination by Dr. M. A. Cain, September 7, 1928:* Probably cancer.

#### X-RAY EXAMINATION (SEPTEMBER 10, 1928)

Marked evidence of deformity of the stomach and transverse colon involving the

body of the stomach. This I should regard as evidence of malignancy.

*Lung fields:* The lung fields do not show evidence of metastasis. The markings are not particularly characteristic.

Barium enema, September 17, 1928, shows non-filling of transverse colon while up to that point there is no evident change in lumen nor hesitation of the clysm. The barium filled the cecum well.

#### GASTRIC ANALYSIS

*Fasting contents:* Free HCl, 0; total acidity, 8 per cent.

*Test meal:* free HCl, 0; total acidity, 9 per cent.

*Urine* was essentially negative.

*Blood:*

|                          | August 8, 1928                | August 27, 1928         | September 11, 1928                                 |
|--------------------------|-------------------------------|-------------------------|--|
| Hemoglobin .....         | 45%                           | .....                   | 60%  |
| Red blood count.....     | 3,020,000                     | .....                   | 4,300,000  |
| White blood count.....   | 5,600                         | 6,400                   | 5,100  |
| Polymorphonuclears ..... | 50%                           | 52%                     | 55%  |
| Lymphocytes .....        | 45%                           | 41%                     | 40%  |
| Large mononuclears ..... | 5%                            | 6%                      | 3%   |
| Eosinophiles .....       | 0                             | 1                       | 1  |
| Basophiles .....         | 0                             | 0                       | 1  |
| Smear .....              | Evidence of secondary anemia. | Shows secondary anemia. | Shows second degree anemia; no pathology; w. h. c. |

#### AUTOPSY FINDINGS

Autopsy performed October 29, 1929, by Dr. J. H. Ferguson.

(A. V. P., male, white, age 42 years.) Body is that of a fairly well developed, very poorly nourished adult male 168 cm. long, weighing 115 pounds. Rigor mortis is moderate. Liver mortis is moderate in the dependent portions. Scalp, ears, nose, and mouth are negative. Pupils are rather markedly dilated, and equal. The anterior and posterior cervical glands and the submaxillary, axillary, and inguinal glands are palpable and apparently somewhat enlarged. There is a small, healing scar in the left axillary region.

*Peritoneal cavity:* Peritoneum is smooth

and glistening. Cavity contains approximately 200 c.c. of rather thick, grayish-white fluid. Diaphragm extends to the fourth interspace on the right, fifth rib on the left. There are no adhesions between the liver, spleen, and diaphragm. Foramen of Winslow is apparently closed, due to numerous enlarged lymph nodes. Lesser peritoneal cavity is practically obliterated by large tumor masses, which are apparently retroperitoneal. Appendix is considerably larger in diameter than usual. The blood vessels of the serosa are somewhat injected. The lower portion of the ileum is apparently considerably thickened. Numerous grayish areas of thickening of the wall along the free margin of the ileum may be seen and palpated. The upper portion of the rectum and the sigmoid colon are firmly matted together

in the true pelvis and are apparently involved in a large tumor mass which occupies a major portion of the pelvis. The wall of the entire colon and cecum seems to be considerably thickened. In the right upper quadrant, near the region of the hepatic flexure, there is a rather sharp angulation of the transverse colon. This is apparently caused by adhesions of the peritoneum and numerous large yellowish-brown nodules which are apparently lymph nodes. Stomach is apparently markedly dilated. The stomach wall is much thicker than usual and seems by palpation to be somewhat nodular. The lymph nodes in the greater and lesser omentum and along the greater curvature of the stomach are enormously enlarged and

vary in size from 1 to 3 cm. in diameter. The lymph nodes along the large intestine are also considerably enlarged. The mesenteric lymph nodes are enormously enlarged and vary in size from 1 to 3 or 4 cm. in diameter. Along the base of the mesentery

mediastinum are slightly enlarged. The sub-sternal lymph nodes are considerably enlarged and on section resemble those in the peritoneal cavity.

*Pericardial cavity:* Cavity contains from 8 to 10 c.c. of clear straw-colored fluid.

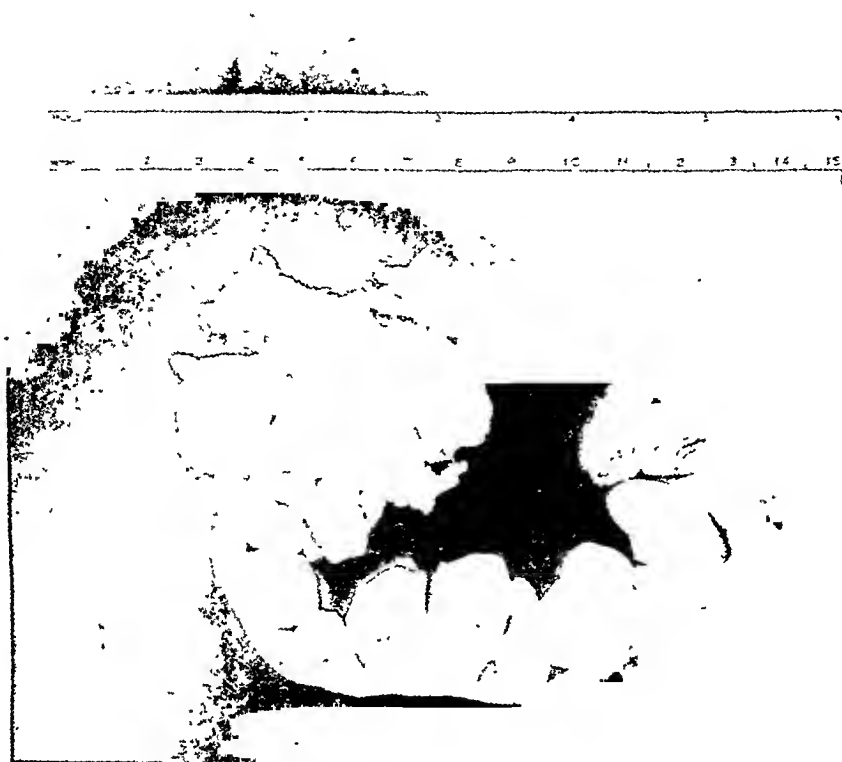


Fig 3 Section of stomach through tumors.

there is a large retroperitoneal mass which is apparently made up of numerous small masses. This mass is approximately from 6 to 8 cm. in diameter and displaces the gastro-intestinal tract anteriorly. All of these masses on section are found to be yellowish and grayish-white in color and are apparently lymph nodes.

*Pleural cavities:* The left pleural cavity contains approximately 150 c.c. of rather thick grayish-white fluid, resembling the fluid found in the peritoneal cavity. The right cavity contains no free fluid. There are no adhesions.

*Mediastinum* The lymph nodes of the

Pulmonary artery opened *in situ* is without evident lesion.

*Heart:* Weight 200 grams. It is apparently much smaller than usual. There is considerable edema of the visceral pericardium. Cavities contain a moderate amount of fluid blood and blood clot. Valves are without evident lesion. Coronary arteries are without evident lesion. Myocardium is reddish-brown in color. Markings are distinct.

*Lungs:* Weight of left, 250 grams; of right, 240 grams. Both lungs are crepitant throughout. In the apex of the right lung there is a small area from 1 to 2 cm. in

diameter in which the pleura shows some grayish thickening. Beneath this thickening may be seen a few small grayish-white nodules, pin-point to pin-head in size. On section, the lung substance is found to be reddish-gray in color. On pressure a very slight amount of reddish fluid may be expressed. Vessels, bronchi, and bronchial lymph nodes are not unusual.

*Spleen:* Weight 340 grams. On section, the color is found to be rather dark reddish-purple. Pulp is firm. The Malpighian corpuscles are considerably enlarged and in areas tend to be fused.

*Liver:* Weight 1,590 grams. Surface is smooth and capsule transparent. On section, the liver substance is found to be reddish-brown in color. Markings are fairly distinct.

*Gall bladder and ducts:* Gall bladder contains a moderate amount of golden yellow bile. There are no stones. Mucous membrane is without evident lesion. The common bile duct passes through a mass of apparently enlarged lymph nodes to reach the duodenum. There is apparently no obstruction.

The entire gastro-intestinal tract, kidneys, aorta, and organs of the pelvis were removed *en masse*.

*Gastro-intestinal tract:* The mucous membrane of the esophagus is studded with numerous grayish-white areas, apparently hypertrophied lymphoid tissue. The wall of the stomach is markedly thickened, which thickening apparently involves the entire wall. There is marked hypertrophy of the rugæ, so that in many instances they are from 1 to 2 cm. in thickness. On section through these rugæ they are found to be light yellowish-gray in color and soft in consistency. Scattered throughout the stomach wall are rather numerous masses which are apparently beneath the mucous membrane. There is no evidence of ulceration. The largest of these masses is from 4 to 5 cm.

in diameter and from 1 to 2.5 cm. in thickness. The pylorus is widely patent. The wall of the first part of the duodenum is considerably thickened, with no evident tumor formation. In the ileum the Peyer's patches are markedly enlarged and thickened. The solitary lymph nodules of the



Fig. 4. Photomicrograph through tumor  $\times 200$ .

lower ileum stand out as masses from 0.2 to 0.5 cm. in diameter. The solitary lymph nodules of the large intestine are enlarged to the same degree, so that the entire mucous membrane of the large intestine is covered with nodules which are somewhat polypoid in character. In the sigmoid colon there is considerable generalized thickening of the entire wall in addition to the hypertrophy of the solitary lymph nodules. The pancreas seems to be entirely surrounded by what are apparently enlarged lymph nodes. There is no evidence of infiltration into the pancreas. The kidneys are not unusual on external examination; on section, the color is found to be a rather dark reddish-brown. Markings are fairly distinct. The pelves and ureters are not abnormal. The aorta is without evident gross lesion. The remainder of the mass is apparently made up of compact

masses of fairly discrete nodules which are apparently enlarged lymph nodes.

#### ANATOMICAL DIAGNOSIS

Apparently malignant tumor involving the lymphoid tissue of the entire body. Possibly some pulmonary tuberculosis.

This case is reported by the Radiological Department of the Syracuse University Hospital of the Good Shepherd and appreciation is expressed to the medical, surgical, laboratory, and pathological services for their co-operation in making the presentation possible.

### INTUSSUSCEPTION

#### CASE REPORT

By CLARENCE E. WEAVER, M.D.,  
DETROIT, MICHIGAN

Intussusception occurs clinically in two forms—the acute type, which is seen mostly in male infants—more than half occur before the age of one year—and the chronic form, which is more common in men between the ages of 20 and 40 years. The causes are irregular peristalsis (sometimes induced by worms), diarrhea, polypoid tumors, or other forms of irritation. Brown and Sampson mention intussusception as a complication of intestinal tuberculosis, and cite two cases. Keen's "Surgery" gives non-malignant tumors, usually pedunculated, mostly in adults, as a not infrequent cause, and states that Weiss in his study of the literature referred to sixteen such cases. A subserous lipoma of the cecum was responsible for invagination in a case of Marchand's. Keen also states that ulcers of the bowel have been found as a cause—as in dysentery and tuberculosis—and cites such a case reported by Orten.

On account of the comparative rarity of

chronic intussusception in adults, and the fact that case reports of such pathology are not numerous, the following case is considered worthy of report.

Mrs. J. G., age 40 (seen January 8, 1929), had been suffering from marked constipation for several years. Since December, 1928, she had complained of eructations of gas, associated with cramps, flatulence, and small nodular stools. No loss in weight.

*Physical examination.*—Negative, except that the abdomen was more than normally tympanitic, especially on the right side. No palpable masses. Blood and urine examination essentially negative.

*X-ray examination (January 8, 1929).*—No organic pathology of the stomach or duodenum was seen. No spasm was noted. Emptying was normal. The five-hour examination showed most of the meal in the terminal ileum, with a small amount in the ascending colon. The terminal ileum was not dilated. The ascending colon was mod-



Fig. 1. Five-hour examination showing terminal ileum apparently entering dilated cecum and ascending colon.



Fig 2 First barium enema. No filling defect is present. The caliber of the colon is normal.

erately dilated. The terminal ileum could be seen to pass within or behind the lower part of the ascending colon. This might be due to intussusception, or possibly to an old inflammation about the cecum and ascending colon, with bunching of these parts by adhesions. The twenty-four-hour examination showed a ring outline in the middle of the transverse colon, suggesting displacement of barium by a round smooth mass, possibly a benign tumor. The colon was dilated proximal to this, the caliber being considerably smaller on the distal side.

The barium enema passed readily to the middle of the transverse colon, was momentarily arrested here, a suggestion of filling defect was seen, which then disappeared, the enema passing on to the cecum, filling the entire colon normally and showing a normal caliber throughout. No filling defect of the transverse colon was demonstrable

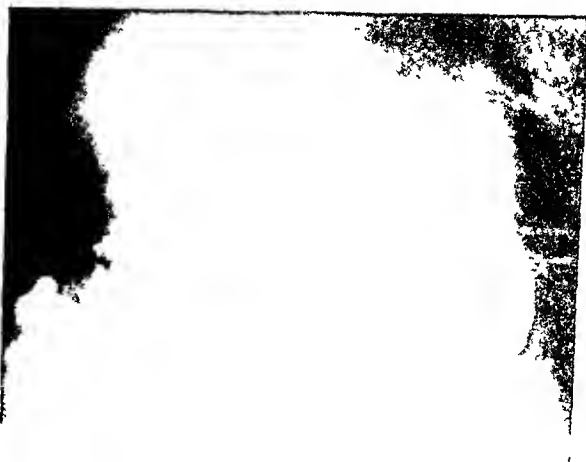


Fig. 3. Condition immediately after evacuation of the first enema. Large smooth filling defect in middle of transverse colon, with dilated bowel on proximal side and collapsed bowel distal to it.

by manipulation of this area. After evacuation of the enema, the filling defect of the transverse colon was again present, with the change in caliber at this point as noted at the twenty-four-hour observation.

At a later X-ray examination (March 13, 1929), a barium enema was entirely obstructed at the middle of the transverse colon, and a smooth central defect was easily seen before and after evacuation of the enema. These X-ray findings suggested intussusception or possible benign tumor of the transverse colon, causing partial obstruction.

Operation by Dr. C. D. Brooks, Dr. W. R. Clinton, and Dr. L. B. Ashley (March 16, 1929) showed intussusception of the cecum, terminal ileum, and hepatic flexure into the transverse colon. This was reduced without traction, and a large, apparently smooth encapsulated tumor about  $2\frac{1}{2}$  inches in diameter was found in the cecal wall near the ileocecal junction. There was no involvement of the ileocecal glands, or glands of the mesocolon. Ileocolostomy was done, with the usual lateral anastomosis in the transverse colon to the lower part of the ileum, at least 8 inches from the ileocecal valve.

At a second operation (April 23, 1929) the terminal ileum, cecum, ascending colon,



*Laboratory report by Dr. P. F. Morse (April 26, 1929).—Chronic inflammation and ulceration of the large intestine. No malignancy was found.*

At the present writing, October 15, 1930, the patient is entirely well.

This case is interesting in that it illustrates some of the typical signs of chronic intussusception, and yet presents some confusing aspects which tend to render the diagnosis of these conditions difficult, especially as they are not commonly encountered. It is interesting to note that the intussusception was reduced by the first enema, and immediately recurred with evacuation, and that the same type of examination two months later showed practically complete obstruction to the enema, with a well marked filling defect.



Fig 4 Enema, two months later, showing large filling defect in transverse colon, with almost complete obstruction to the enema at this point

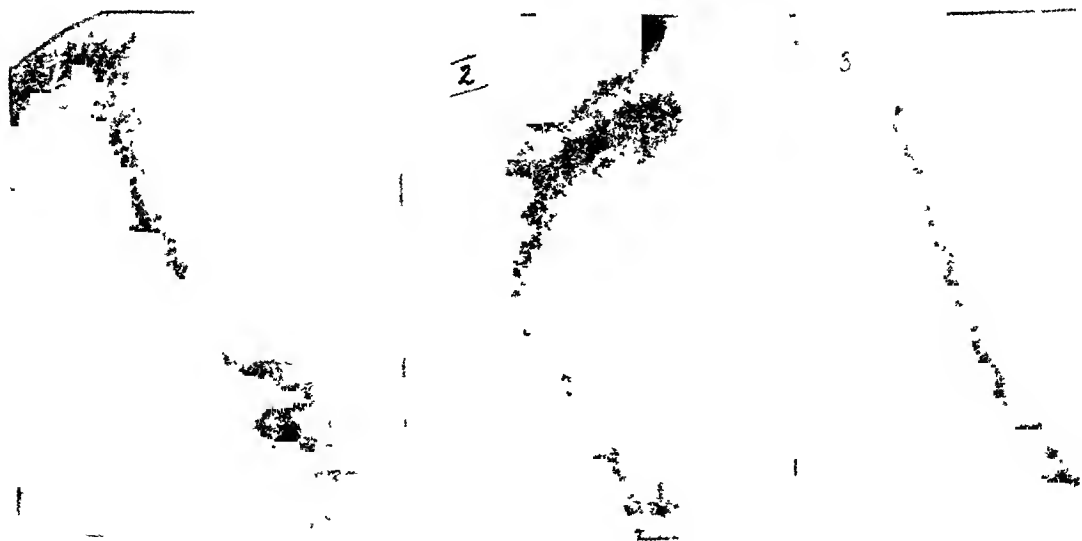
## DOUBLE GALL BLADDER, WITH DOUBLE CYSTIC DUCT

### CASE REPORT

By RICHARD HAYES, M.D.,  
LONGVIEW, WASHINGTON

The patient, a male of 35, with rather in-

and right half of the transverse colon were resected, with the end of the ileum and colon inverted with three purse-string sutures



Figs. 1 and 2 Films taken at intervals of 13 and 16 hours, respectively, showing two gall bladders (See page 67)

Fig 3. Film taken at interval of 19 hours, after the so-called fat meal.



Figs. 4 and 5. Films taken after a subsequent intravenous administration of dye.

definite gastro-intestinal symptoms, was referred for complete roentgen examination.

The gall-bladder dye was first administered orally, giving us the films shown in Figures 1, 2, and 3, taken at intervals of 13, 16, and 19 hours, respectively. The film shown in Figure 3 was taken after the so-called *fat meal*.

As a matter of interest, the dye was again given after a few days, this time intravenously, with the resultant change in position of the gall bladders, as seen in the films reproduced in Figures 4 and 5. There was no dye left this time after the fat meal.

There is hardly any doubt but that we have here two gall bladders, which we consider normal ones, with two long independent cystic ducts. In Figures 1 and 2, the organs seem to swing in line with one another, while in Figures 4 and 5 the uppermost gall bladder appears to swing outward and the lower one to fold upward.

A continuation of the examination has shown that the patient has a duodenal ulcer, for which he is being treated medically.

Dr. Sherwood Moore was kind enough to review the films and diagnosis in this case.

# EDITORIAL

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M. J. HUBENY, M.D. . . . . *Editor*  
BENJAMIN H. ORNDOFF, M.D. . . . *Associate Editor*

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## ROENTGENOLOGY AND INTERNSHIP

The increase in the number of accessories to diagnosis and treatment in medical practice has been so rapid as to bewilder the average old-time practitioner. He has been too busy to withdraw from his work regularly to pursue the graduate work which might have aided him in keeping abreast of the times. Medical journals are coming to convey medical ideas in language which he can barely understand and meagerly comprehend. His armamentarium is becoming as obsolete as his saddlebags. He views with cynicism the novel ways of the new competitive medical recruit. In efforts to justify himself, he casts insidious reflections upon the efforts of his rival novice to establish in practice a system of scientific research and clinical pursuit.

Among other essential aids to the successful practice of medicine, radiology has attained a well established place. Its reception by the profession and the laity was less hampered than was that of some other now accepted adjuncts to practice. The appeal to the sense of sight gave a rational impression, which readily appealed to clinicians in legitimate practice as well as to the eager mercenary observers on the side lines. Commercial enterprises soon recognized the portent of this accessory and proceeded to de-

velop all types of apparatus. Being manufactured, they needed to be sold, and strenuous efforts were made profitably to dispose of the various electrical machines. Thus was established another of the many anomalous situations so frequently observed in the evolution of medical science—a commercial world foisting its hypothetical and unproven products upon a scientific profession. Ere long medically trained mechanists developed more rational and serviceable apparatus.

Again, crafty tradesmanship produced machines faster than medical education could develop qualified operators. The obvious outcome was poor clinical results under legitimate management and dreadful results under the reckless direction of unscrupulous exploiters. Laws and administrative means of control became imperative. Inasmuch as a license to practise medicine carries with it a right to use any legitimate measure which will benefit the patient, every such licensed person was permitted to buy an X-ray outfit and proceed to experiment with it on patients. Eventually, out of intelligent research work a standard of technique has been developed which every operator now should know. Gross experimentation should no longer be tolerated even under the cautious tactics of untrained physicians, and much less under the careless commercialism of illegal practitioners. Professional ethics now rightly demand skillfully trained clinical technicians and experienced interpreters in this important medical procedure.

In the State of Pennsylvania, where intern law was passed in 1914, there can be found barely two dozen relatively competent roentgenologists to man the



BUNDY ALLEN, M D, Tampa, Florida, President of the Radiological  
Society of North America



tories in the hundred hospitals required for intern training. In the larger cities of the State several eminent leaders in this field were made chiefs in all the best institutions. With the divided responsibilities of such a number of laboratories, none received adequate attention. Non-medical technicians were employed to take films and turn them into the chief's private laboratory. Reports and bills came from his office without question or control. This procedure needed to be changed because of the following conditions:

(a) Requisitions were limited, inasmuch as the staff physicians were suspicious of the value of the films taken by a lay-technician. Prompt reports could not be expected.

(b) Staff chiefs could not readily view the films, not having easy access to the opinion of the consulting roentgenologist.

(c) Plates were not filed in the hospital for future protection of the hospital and staff. Subsequent study of cases was not practicable.

(d) Fees not being regulated, the unreasonableness of these frequently brought reproach upon all concerned. Suspicions of inordinate fee-exactions were not without foundation.

(e) The monopolistic attitude of these roentgenologists hampered the development of successors, or the liberal education of other physicians in the value of this specialty.

(f) Hospital administrators were urged to furnish equipment, the proceeds of the use of which would go into private coffers. This was not unlike the evolution of the community hospital in earlier days under the energetic promptings of an ambitious surgeon.

A cursory investigation, then, of the conditions present in the hospitals of the State in which internship training might be feasible, revealed the fact that a complete staff-

reorganization in most institutions would be necessary. The law implied that the recent medical graduate should have a year of apprenticeship in medicine under supervision. Departmental heads, chiefs of staff departments, needed to be designated, and, in many cases, needed to be supplied. This was particularly true in laboratory management. Search for such specialists frequently was futile; an adequate number could not be found, neither was there evidence of any rapid increase forthcoming.

A demand by the State Board that the X-ray department be headed by a chief who was available throughout a large part of the day to supervise the technical work, to consult with staff physicians, and to direct and teach interns caused a veritable consternation in hospital administration. The requirement, however, readily induced many eager, alert, and adaptable young physicians to seek special training in radiology so as to meet this imperative demand. Now, after sixteen years of intern requirement, we have reason to be proud of our radiological personnel and to be better satisfied with their teaching to interns.

Furthermore, the State Board has always required a sufficient intern training in technic to assure a knowledge of the dangers of the machines, and to assure an abundance of experience in plate reading. It wants every prospective practitioner coming into the State to have a comprehensive knowledge of the value of this adjunct to medicine and wants him to recognize the responsibility one assumes in its hazardous management.

After sixteen years of intern training, more than half of the fourteen thousand physicians licensed in the State have had this apprenticeship service in radiology and thereby are peculiarly prepared to make its service available to their patients. They, also, because of this special training, are cheerful boosters of the physicians who

have so marvelously developed this specialty, while on the other hand they are wise guardians for their patrons against the unscrupulous claims of charlatans. "Learning by doing" is a rule equally as valuable in medicine as in general education, provided it is done under intelligent supervision.

IRVIN D. METZGER, M.D.

Pittsburgh, Pa.

*President, State Board  
of Medical Education  
and Licensure*

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### IN MEMORIAM

*RICHARD MARK BROWN, M.D.*

On September 12, 1930, occurred the death of Dr. Brown, of Ogden, Utah, following an operation on September 8 for removal of stone in the common bile duct. Death was due to septicemia and shock.

Dr. Brown was born in Ogden April 17, 1884, the son of Mr. and Mrs. Richard T. Brown, and the grandson of J. J. Murphy, M.D., a prominent pioneer Utah physician, who arrived in that State from Georgia in 1869. Dr. Brown studied medicine at the University of Utah and Columbia University, being graduated from the latter in 1912. He interned in the New York Postgraduate Hospital, to which institution he returned for special training in roentgenology after his service in the World War. In recent years he has confined his practice to roentgenology in Ogden and Salt Lake City, Utah. He leaves a wife (née Wattis) and four young children.

Dr. Brown was a member of his county and state medical societies, the American Roentgen Ray Society, and the Radiological Society of North America, for the latter serving for several years as Counselor of his State.

Dr. Brown's numerous friends extend

their sympathy to his family and experience a sense of loss of a valued co-worker.



WILLIAM B. BOWMAN, M.D.

*WILLIAM BURLEY BOWMAN, M.D.*

On September 24, 1930, occurred the sudden death of this well-known member of the Society. Dr. Bowman had been active in the matter of preparations for the Annual Meeting, and his loss is keenly felt.

He was born on November 7, 1885, at Martin's Ferry, Ohio, and received his education in Cincinnati and St. Louis. Since 1910 he had practised medicine in Los Angeles, California, his specialization in radiology dating from about 1913. He served in the Army for more than two years during the World War, having the rank of Major, Medical Corps. Dr. Bowman was a mem-

ber of his county and state medical societies, the American Roentgen Ray Society (Vice-president in 1916), the Radiological Society of North America (Vice-president in 1925), as well as various local medical bodies, fraternities, the Masonic order, and country clubs. Dr. Bowman was unmarried. He was the author of numerous papers contributed to medical literature.

"Bill Bowman" was beloved by his associates, and hosts of friends mourn his passing.

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### *PRESTON M. HICKEY, M.D.*

Preston Manasseh Hickey, aged 65. Professor of Roentgenology at the University of Michigan, died October 30, 1930, at the University Hospital of a coronary thrombus after an acute illness of about five days' duration, preceded by a prolonged period of disability. In spite of ill health, Dr. Hickey remained active in teaching and administrative work. Realizing the seriousness of his illness, he retained his patience, good nature, and sunny disposition to the very end. He frequently remarked, "Chronic disease limits one's capacity, but why shouldn't I make the best of things as they are? Work, in moderation, requires less energy than lying in bed thinking about one's illness." Literally, he passed to the Great Beyond in the midst of activity. How wonderful!

Dr. Hickey was born December 3, 1865, at Ypsilanti, Michigan, the son of Manasseh Hickey, a noted Methodist minister, and Sarah Bush Hickey. He attended the University of Michigan and received the degree of Bachelor of Arts in 1888; was graduated from the Detroit College of Medicine in 1892, and entered private practice immediately after graduation. He remained in Detroit until 1922, when he was called to the University of Michigan as Professor of

Roentgenology, succeeding the late Dr. James G. Van Zwaluwenburg.

He was by nature a diligent student, a



PRESTON M. HICKEY, M.D.

teacher, an organizer, and a master technician. To him is due the credit for the development of the well-known Hickey Cone, which reduced scattered rays to a minimum and gave finer roentgenographic detail. He recognized the potential danger of the X-ray to both operators and patients, and even though Dr. Hickey pioneered in this scientific field his hands and fingers showed no result of atrophy.

Very early in the field of X-ray development he advocated lateral plates on the hip and spine. He was one of the earliest workers in studying X-ray findings in post-mortems, thereby eliminating the physiological motor phenomena which are now known to be of considerable importance in the in-



terpretation of films made on living subjects.

He was a master photographer and demonstrated the method of photographing specimens free from shadows.

Before studying medicine he taught biology, and after graduation pathology in the Detroit College of Medicine, and was pathologist to the Woman's Hospital from 1894 to 1901. He was Professor of Roentgenology in his medical alma mater from 1909 to 1922.

He was the roentgenologist of Harper, the Children's, and the Receiving Hospitals, and organizer of the old Detroit Camera Club. He was the great spirit in founding the *American Journal of Roentgenology and Radium Therapy*, of which he was Editor for many years. He was President of the American Roentgen Ray Society in 1906-07.

During the War he was rated as Lieutenant-colonel in the Medical Corps, U. S. Army, and from August, 1917, to January, 1919, was stationed in France as consultant in radiology for the American Expeditionary Forces.

He was the Caldwell Lecturer of the American Roentgen Ray Society at its Kansas City meeting in 1928, at which time he gave a very able lecture on the contributions of the great Caldwell himself. He was President of the American College of Radiology the same year.

Dr. Hickey was a member of the American Medical Association, the College of Surgeons, the College of Physicians, the College of Radiology, belonging as well to many of the local state and county societies, of both Wayne and Washtenaw. It would be useless for us to attempt to list a bibliography of his contributions; his articles have covered a diversified field in radiology and in medical education.

His professional life, as shown by the above enumerated activities, was a very orderly and gradual development. His

knowledge of biology, pathology, and photography formed an excellent foundation on which to analyze and interpret the evaluation of recorded densities, as shown in health and in disease, and how the bombarding electrons liberate electro-magnetic waves which affect the living cells of plants and animals, including the genus *homo*.

In his experimental work, he was quick to adopt new ideas and uncanny in estimating their scientific worth, the results of which he passed on either in articles or verbally to his confrères—always done with an altruistic spirit. A selfish motive was absolutely foreign to his ultra-scientific approach. His entire life was devoted to elevating the plane of roentgenology in America and to placing it on a par with the other specialties. In his address as President of the American Roentgen Ray Society in 1907, he said: "Broadly speaking, the dignity of roentgenology as a separate branch of modern medicine has not been steadfastly upheld; the proper respect is not always accorded to the roentgenologist. The specialist in this branch of the profession should be recognized by his medical brothers as a consultant, and should be treated and remunerated upon that basis."

His influence on students and associates was striking in that he imparted much of his own enthusiasm to their activities. Such a rare quality is indeed a mark of a great leader and teacher. He was recognized by the undergraduate body as a friend—a friend of the young man—and a counselor to the young doctor. To many he extended a helping hand: to none a deaf ear. To those whom he helped, his life will ever be an inspiration.

He contributed many articles on the undergraduate instruction in roentgenology, on post-graduate instruction, and on hospital organization. His ability as an organizer was of a grade rarely found in a physician.

The numerous societies of which Dr. Hickey was an active member will join with his family—his widow, Grace, a daughter, Mrs. Trine Pattengill, and two sons, Walter Preston and Guy Ransome, all of Ann Arbor—in mourning his loss.

The Radiological Society of North America has been glorified by his membership and his many achievements have added luster to American and foreign roentgenology. In his demise, science has lost an invaluable exponent and the world has lost a friend to man!

ROLLIN H. STEVENS, M.D.,  
CLYDE K. HASLEV, M.D.

## MINNESOTA RADIOLOGICAL SOCIETY

A meeting of the Minnesota Radiological Society was held at the University Hospital, Minneapolis, Minnesota, on October 25, 1930. The following program was presented:

Roentgen Studies on the Onset of Lobar Pneumonia. Walter H. Ude, M.D., Minneapolis. Discussed by George E. Fahr, M.D., Minneapolis.

Childhood Tuberculosis. Malcolm B. Hanson, M.D., Minneapolis. Discussed by Jay A. Myers, M.D., Minneapolis.

Lympho-epithelioma. A. U. Desjardins, M.D., Rochester, Minnesota.

Air Injection in the Diagnosis of Lesions of the Colon. Harry M. Weber, M.D., Rochester, Minnesota.

Roentgen Therapy in Carcinomatous Metastases to Bone. K. W. Stenstrom, Ph.D., and L. G. Erickson, M.D., Minneapolis.

An informal dinner was held at the Town and Country Club, Dr. W. A. O'Brien acting as toastmaster. The Society was honored by

the presence of two distinguished guests, Dr. James L. Martin, of Dallas, Texas, and Dr. Bernard H. Nichols, of Cleveland, Ohio. The following papers were presented:

Significance of Small-intestinal Gas in the Diagnosis of Bowel Obstruction. Edward Schous, M.D., St. Paul.

Clinical and Experimental Studies on Intestinal Obstruction. Owen H. Wangensteen, M.D., Minneapolis.

Intravenous Urography. Bernard H. Nichols, M.D., Cleveland, Ohio.

At the business meeting new officers were elected for the coming year, as follows: B. R. Kirklin, M.D., of Rochester, *President*; Gage Clement, M.D., of Duluth, *Vice-president*, and Leo G. Rigler, M.D., of Minneapolis, *Secretary-Treasurer*.

The time and place of the next meeting will be decided by the Executive Committee at an early date.

LEO G. RIGLER, M.D., *Secretary*.

## BROOKLYN ROENTGEN RAY SOCIETY

It is with pleasure we announce that the radiologists of Brooklyn, New York, have recently joined together and formed an organization to be known as the Brooklyn Roentgen Ray Society. After several preliminary meetings, the Society came into existence on December 2, 1930, at which time a Constitution and By-laws were adopted.

The officers are as follows: *President*, Charles Eastmond, M.D.; *Vice-president*, William H. Bayles, M.D.; *Secretary-Treasurer*, John J. Masterson, M.D., 401 Seventy-sixth St., Brooklyn, New York.

The Society will meet regularly on the first Tuesday of each month, from October to April.

# REGISTRATION IN THE THIRD INTERNATIONAL CONGRESS OF RADIOLOGY

*Paris, July 27 to 31, 1931*

A written announcement of communications intended for the Congress will have to be sent in before January 1, 1931. A type-written English, French, or German abstract, not exceeding one printed page (400 words) of each communication should reach the office of the Congress before April 1, 1931. These abstracts will be printed in a volume handed to members before the opening of the Congress.

Each member is entitled to one communication only, the reading of which is not to exceed 15 minutes.

Should the announced communications be too numerous to be all read, the Bureau of the Congress will have the right to limit their number or shorten the time of reading.

A blank form for enrollment will be sent upon request. Members of the various societies of medical radiology wishing to take part in the Congress are requested to fill in and return this blank as soon as possible, together with the sum of 300 French francs as fee for membership.

An exhibition will be arranged in connection with the Congress. Persons or firms wishing to take part in the exhibition will obtain all particulars from M. H. Pilon, Commissary-general of the exhibition, 34, boulevard de Vaugirard, Paris (15), France.

Further information will be forwarded later to all those who have enrolled and sent their fee to the Congress.

Members of the Congress accompanied by members of their families desirous of attending, as adjoined members, the receptions and festivities given during the Congress, will please state on the blank form the number of these persons and pay a fee of 50 French francs for each of them.

Please address all communications and correspondence to the offices of the Third International Congress of Radiology, 122, rue La Boétie, Paris (8), France.

## ABBOTT LABORATORIES AND SWAN-MYERS COMPANY JOIN FORCES

In order to enlarge the research facilities and personnel of both companies, to expand the sales organizations and increase the distribution of their ethical pharmaceutical products, the Abbott Laboratories, of North Chicago, Illinois, and the Swan-Myers Company, of Indianapolis, Indiana, have agreed to combine their resources and consolidate their management. This combination brings into one enlarged organization two groups of persons actuated by the same standards in ethics, scientific research, and controlled manufacture.

Alfred S. Burdick, President of the Abbott Laboratories, states that among those to join the active management of the combined companies in North Chicago are R. M. Cain, who will be Vice-president in charge of sales; Edgar B. Carter, Director of Biological Laboratories; O. C. Durham, in charge of pollens and allergy products, A. E. Snyder, C. R. Jackson and others.

The Swan-Myers business was organized in 1909 and has developed a line of ephedrine products, bacterial vaccines, ampules, pollens and pollen extracts and intravenous solutions, dextrose and other ampules, ophthalmic and nasal ointments, glandular and kerakote products and other specialties. Its Ephedrine Inhalant "66" was the first plain inhalant to be accepted by the Council on Pharmacy and Chemistry of the American Medical Association.

E. H. Volwiler, Chief Chemist of the Abbott Laboratories, becomes a member of the Board of Directors; also James F. Stiles, who has been elected Treasurer, and Ed-

mund L. Drach. S. DeWitt Clough becomes Vice-president and F. W. Scheigert, Secretary. The laboratories of the Swan-Myers Company will continue to be operated in Indianapolis until further notice.

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### ANOTHER MEMBER ELECTED TO PRESIDENCY OF HIS STATE SOCIETY

George C. McElfatrick, M.D., Counselor of the Radiological Society of North America for Delaware, has been elected to the presidency of the Medical Society of Delaware, to take office at the beginning of the year. The other incoming officers are: *First Vice-president*, W. F. Haines, M.D., of Seaford; *Second Vice-president*, C. J. Prickett, M.D., of Smyrna; *Secretary*, W. O. LaMotte, M.D., of Wilmington; *Treasurer*, S. C. Rumford, M.D., of Wilmington.

It is a matter for congratulation that radiologists hold positions of honor in their state societies. It is in such ways that close ties of co-operation between clinicians, surgeons, and radiologists are formed.

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### ENCOURAGEMENT OF RESEARCH

A grant has been made by the Committee on Scientific Research of the American Medical Association to Dr. Clinton H. Thienes, Associate Professor of Pharmacology of the School of Medicine of the University of Southern California, according to an announcement issued by Dr. William D. Cutter, Dean. The grant of five hundred dollars is for research on the relationship between the mesenteric plexus and ganglia and the mesenteric nerves. Professor Thienes is attacking this problem from the anatomical and

pharmacological standpoints. He states that the knowledge of the intestinal nervous system is meager, and that there is much uncertainty among medical men as to what are the anatomical relations and functions of the nerves which go from the central nervous system to the alimentary tract. There is a network of nerve fibers and cells in the wall of the digestive tract which is considered by some scientists to represent the termination of the mesenteric nerves—nerves of a membrane of the abdominal cavity which connects the intestine with the abdominal wall. Other scientists look upon this plexus as an independent nervous system whose function it is to carry on the automatic motor functions of stomach and intestine.

According to Dr. Thienes, the action of drugs upon the intestinal tract frequently does not correspond with the action of the same drugs in other parts of the body. The purpose of these studies is to establish, if possible, an anatomic and physiologic basis for these differences in drug action.

The Committee on Scientific Research is headed by Dr. Ludvig Hektoen, of Chicago, who, according to his record in "American Men of Science," is one of the Nation's outstanding pathologists.

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### EDWARD MALLINCKRODT INSTITUTE OF RADIOLOGY

The cornerstone of the Edward Mallinckrodt Institute of Radiology of Washington University, St. Louis, was laid on October 2, 1930. The copper box placed within it contained a portrait of the late Edward Mallinckrodt, Sr., donor of \$300,000 toward the erection of the institute.

# BOOK REV.

X-RAY CRYSTALLOGRAPHY. By R. W. JAMES, M.A., B.Sc., Senior Lecturer in Physics in the University of Manchester. With a general preface by O. W. RICHARDSON, F.R.S., Yarrow Research professor of the Royal Society, Nobel Laureate in Physics, 1928. Pages, 88; diagrams, 29. Published by E. P. Dutton & Co., Inc., New York, 1930. Price, \$1.15.

This little treatise by the well-known Senior Lecturer in Physics at the University of Manchester is one of a series of monographs on physical subjects. In the preface by Professor O. W. Richardson the hope is expressed that the monographs may be of great service to physics students who have examinations to consider, to those who are engaged in research and other branches of physics and allied science, and to the large number of science masters and others interested in the development of physical science who are no longer in close contact with recent work. The subjects considered in the five chapters by Professor James are crystal form and the space groups, the crystal lattice as a diffraction grating, a symmetry of crystals and their determination by means of X-rays, the intensity of X-ray spectra, and types of crystal structure. Within the limited scope of so small a book obviously only the most general methods can be employed, but the presentation has been made with the greatest skill. It is difficult to imagine how scientific material could be more accurately described for the lay reader than has been done in this case. To the members of the medical profession who are interested in X-ray applications but are not familiar with the diffraction science and researches of the chemist and physicist, this is an excellent brief elementary but true introduction. It serves as a real appetizer in

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able lines of the complicated human skull offer great difficulties. The expert will gladly consult it for advice.

We will eagerly await the second part of this work, containing twenty-two double illustrations, which will be available at the end of 1930.

F. HAENISCH, M.D., (Hamburg, Germany)

**DIE RÖNTGENBEHANDLUNG DER NERVENKRANKHEITEN** (The Roentgen Treatment of Diseases of the Nervous System). By PROFESSOR DR. OTTO WARBURG and DOZ. DR. MAX SGAULTZER, University of Vienna. Pages, 213, with 4 cuts in the text; paper. Supplement to "Strahlentherapie," No. 15, published by Urban & Schwarzenberg, Berlin and Vienna, 1930.

This book, which represents the combined efforts of a neurologist and a radiologist, is a summary and critical evaluation of the roentgen treatment of diseases of the nervous system.

In the "general part" (pages 3-50) are discussed the physical and biologic foundations of roentgen therapy and the authors' technic of treatment of various disorders of the nervous system.

In the "special part" (pages 53-213) are discussed (1) brain tumors; (2) pituitary tumors; (3) meningitis serosa, hydrocephalus, lymphorrhoea, headache; (4) epilepsy; (5) cord tumors; (6) compression syndromes; (7) syringomyelia; (8) inflammatory diseases of the nervous system; (9) diseases of the peripheral nerves; (10) angiodystrophic disorders; (11) dysglandular disorders, and (12) psychoses.

One marvels at such an efficient condensation of so many facts into so small a space, for which the authors deserve unlimited commendation. It seems unfortunate that so much valuable information should be available only to those who read German,

and it is hoped that an English edition will soon be forthcoming.

**ALLGEMEINE GRUNDLAGEN: PHYSIK UND TECHNIK DES RÖNTGENVERFAHRENS.** Mit einem Vorwort von UNIV.-PROF. DR. FRIEDRICH DESSAUER. By M. BRENZINGER, Dipl.-Ing., A. JANITZKY, Dipl.-Ing., and DR. E. WILHELMY (Frankfurt a. M.). Pages, 237; illustrations, 275. XIV Band der Radiologische Praktika. Verlag Georg Thieme, Leipzig, 1930. Price M. 25,50 (S. 12).

This volume is intended to continue the tradition of the "Leitfaden des Röntgenverfahrens" by Dessauer and Wiesener, which was well known before the War. Three men especially experienced in their fields have written this book with the same viewpoints. The first part, about one hundred pages, pertaining to the physics of roentgenology, has been written by E. Wilhelmy. The laws of electricity and the physics of the roentgen rays are described in a clear and well arranged manner. M. Brenzinger gives a description of the different roentgen apparatus in the second part. The construction and structure of the induction apparatus, the transformer, and the constant potential apparatus are explained very instructively. After going into the danger from roentgen apparatus, an extensive description of modern machines follows. The third part, in which A. Janitzky deals with the roentgen and other vacuum tubes, will be especially welcome to physicians, as it seems that here a physicist has succeeded in talking intelligently to a physician and not expecting too much technical knowledge. The cathode tubes are explained from their first beginning in every respect. All types of tubes are described and the good old gas tube has not been forgotten.

A bibliography is appended to each chapter. The book has been very finely executed by the publisher, and the numerous illustrations are well made. It will surely find many readers.

F. HAENISCH, M.D., (Hamburg, Germany)  
*Translation by H. W. HEFKE, M.D. (Milwaukee, Wisc.)*

DISEASES OF THE URINARY TRACT IN CHILDREN. By EDWIN BEER, M.D., and ABRAHAM HYMAN, M.D. Pages, 328; illustrations, 50. Published by Paul B. Hoeber, Inc., New York, 1930. Price, \$6.00.

The publication of this volume is quite timely and is indicative of the increasing interest in urologic conditions in children, in which Dr. Beer is one of the pioneer investigators. The development of the book is along the line of clinical investigation. The treatment for many of the conditions mentioned is purely surgical, but the authors do not attempt to include any discussion of surgical technic. Since the tenor of the volume is surgical, a more detailed discussion of medical treatment is probably not warranted. The subject matter is handled in an informal, conversational style and is adequately supplemented by brief case reports which bring out the individual differences possible in cases of the same type. At the time the book was sent to press the use of intravenous urography had not been sufficiently developed so that the report of any extensive series of cases could be included. However, since this procedure may not prove to be so widely adaptable as was expected, this may not prove to be a lack. The pyelograms, ureterograms, and cystograms are excellent and obviously were prepared by some one who understood the technic thoroughly. The bibliography is well chosen. The chief value of the book is its

emphasis on the urologic approach in consideration of diseases of the urinary tract in children.

THE HEALTH-CARE OF THE BABY: A HANDBOOK AND FEEDING GUIDE FOR PHYSICIANS, MOTHERS, AND NURSES. By LOUIS FISCHER, M.D., Consulting Physician to the Willard Parker and Riverside Hospitals; Consulting Physician to the St. Vincent's Nursery and Babies' Hospital, Montclair, N. J.; Former Instructor in Diseases of Children at the New York Post-graduate Medical School and Hospital, and Former Attending Pediatricist to the Sydenham Hospital of New York and to the Infanterium and Heckscher Foundation and Nursery of New York City. Eighteenth ed., revised. Pages, 248. Published by Funk & Wagnalls Company, New York, 1929. Price, \$1.00.

It is a distinct surprise to find that Funk & Wagnalls Company, champions of correct English, are the publishers of a volume in which errors in subject matter and of expression are so manifest. The chapter on X-ray, with its brief mention of diagnosis and therapy, and the one-page chapter on Transfusion might well have been omitted. This book certainly does not fill any want.

DISEASES OF THE SKIN: A TEXT-BOOK FOR PRACTITIONERS AND STUDENTS. By GEORGE CLINTON ANDREWS, A.B., M.D., Associate Professor of Dermatology, College of Physicians and Surgeons, Columbia University. Pages, 1091; illustrations 988. W. B. Saunders Co., Philadelphia and London, 1930. Price, \$12.00.

Dermatology has been fairly well covered by three or four well-known American textbooks. The subject is, however, so broad in its various aspects that a new book can fill

a definite hiatus, provided that the author is in a position to fill the gap, partially at least. This, Dr. Andrews has done admirably by ignoring much antiquated and often misleading information, by emphasizing modern conceptions frequently evaluated critically by his personal experience, and by placing actinotherapy and other physical therapeutic measures in their proper place. For the latter he is particularly qualified by

years of association with Dr. George Miller MacKee. The bibliography is up-to-date and very desirable for ready reference for the physician interested in the details of any given subject. One wonders, however, in passing, whether the author is familiar with the details of all of the quoted articles. The book is distinctly individualistic and will form an addition to any physician's library, no matter how well stocked it may be.

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## BONE (DIAGNOSIS)

Bilateral Vesalianum Bone of the Foot. Dino Agati. *La Radiologia Medica*, June, 1930, XVII, 683.

The author has observed a vesalianum in the foot of a young athlete. The anomaly is bilateral. The abnormal bone is of a shape different from those previously reported, and of larger dimensions.

The author reviews the theories which have been advanced on the pathogenesis of these superfluous bones, and compares the characteristics of the case in question with those reported by other authors. He admits the epiphyseal origin of the bone, but thinks that we should not discard the hypothesis that functional factors (such as athletic activities) may be the cause of abnormal development. He concludes by summarizing the roentgenologic signs to be considered in differentiating the vesalianum from the sesamoid bone of the fibula, and the fracture of the tuberosity of the "V" bone of the metatarsus.

L. MARINELLI.

Fractures of the Acetabulum. William R. Cubbins, Arthur H. Conley, and James J. Callahan. *Surg., Gynec. and Obst.*, September, 1930, LI, 387.

The authors state they were not satisfied with the classifications as presented in the various texts and articles and give the following classification of fractures of the acetabulum:

*A. Fractures of the rim.*—(1) An oblong fragment on the posterior lip of the acetabulum, essentially that portion contributed by the ischium in its development. (2) An oblong fragment, essentially that portion contributed by the ilium. (3) An oblong fragment, essentially that portion contributed by the pubic bone.

*B. Fractures of the acetabulum involving one or two of the three bones of which it is formed.*—(1) Fracture with displacement inward and backward of the ischial segment and ramus. (2) Fracture with displacement inward of the pubic segment and ramus. (3)

Fracture displacing both the pubic and ischial segments with rami. (4) Fracture with displacement inward and backward of the ilial segment.

*C. Perforating fractures.*—In this type the head is forced through the bottom of the acetabulum with a very small amount of the surrounding bone.

*D. A fracture so extensive that all of the bones are involved and fragmented.*

Under etiology, experimental work done in the anatomical laboratory of Northwestern University Medical School by Charles M. Fox, working with and under the direction of Dr. William E. Schroeder, was published in the *Quarterly Bulletin of Northwestern University Medical School* in April, 1909, and the authors quote from the article as follows:

"We took fourteen cadavers and used only a five-pound hammer, striking the trochanter with the leg extended and slightly adducted. Of the femurs so treated, four promptly fractured the acetabulum in various directions. A fragment of the ilium, one from the ischium, and one from the pubis constitute the so-called inverted Y-shaped fracture and allowed the head of the femur to protrude. The other results were not so typical, the lines of fracture running into the obturator foramen, into the ischiatic notch, and through the rami. Of the remaining six experiments there was one impacted fracture of the neck of the femur and two fractured trochanters and three fractured necks. In four cadavers the blow was applied to the knee, resulting in four fractures of the neck of the femur; it seems to me the greatest importance is to be attached to the position of the head and neck of the femur and the blow. If the force is suddenly applied, the elasticity of the pelvis will be of little or no consequence and the head will be forced through the acetabulum, whereas a slow force will be associated with vertical, ring, and other fractures of the pelvis."

The symptoms of fractures of the rim and the more extensive fractures of the acetabulum are taken up separately. In rim fractures, pain on motion and loss of function are always present. Tenderness around the outer surface of the joint can be elicited in thin or moderately large individuals.

If the ischial portion of the rim is fractured and the patient is in a recumbent position, the limbs will be of the same length. Flexion of the limb and medial rotation of the femur will give a peculiar click and jump. The femur then tends to remain flexed and adducted, but can be easily restored to the original position. If this condition goes undiagnosed

and untreated, serious disability will result, due to repeated subluxations, which are painful. Later a chronic, traumatic arthritis will develop, with more or less destruction of the joint tissues.

If the ilial segment of the rim is fractured, a slight adduction is sometimes necessary to make it click. In fractures of the acetabulum which are perforating or fragmented, the length of the limb varies. Any motion, active or passive, is painful, but flexion is usually possible. Abduction is seldom possible. Marked tenderness over the lower abdomen is nearly always present, while rigidity is common. Blood in the urine is not an uncommon finding. By rectal or vaginal palpation marked tenderness can be elicited and, commonly, a mass will be found where the fracture is located, whether there has been a dislocation inward of the fragments or only a hemorrhage from the fractured bone.

The prognosis and treatment of these cases are discussed.

D. S. CHILDS, M.D.

**Fracture of the Neck of the Femur: End-results in Eighty-six Cases.** John C. Wilson. *California and Western Med.*, October, 1930, XXXIII, 707.

The author discusses the results of eighty-six cases of fracture of the neck of the femur. In discussing the classification of these fractures, he says, "In describing hip-joint fractures, the terms 'intracapsular,' 'extracapsular,' 'medial,' and 'lateral' are frequently used in medical literature, but these terms only add to the disorder because extracapsular or lateral fractures are not fractures of the femoral neck. The neck of the femur is an entity, and much confusion will be avoided if fractures are described according to their true anatomic confines. Fractures of the neck of the femur and those of the intertrochanteric region are not comparable. Intertrochanteric fractures should cause no concern, while the same cannot be said of fractures of the neck of the femur.

"The term 'impacted fracture' is ambiguous. It should be used only when its meaning is clearly understood. Locking of the fragments

may be sufficiently secure to permit weight-bearing, but is in no sense an impaction. A careful study of stereoscopic roentgenograms will demonstrate a complete absence of contact between the fractured surfaces; on the other hand, the X-ray may show a break in continuity of the neck, with a little shortening of the leg and a mild coxa vara."

Under "Treatment," he states, "Stereoscopic X-ray control is essential to check the accuracy of the reduction."

In discussing the causes of failure, he says, "Failure may be attributed to imperfect reduction, insufficient fixation, interposition of soft tissue, or lack of blood supply about the point of fracture. The surgeon has no control over the blood supply, but he can obtain and maintain a reduction. He also has a reasonable opportunity to prevent the interposition of soft tissues."

F. B. SHELTON, M.D.

## BONE DISEASES (DIAGNOSIS)

**A Case of Osteopoikilia.** G. Gr. Awalischwili. *Röntgenpraxis*, Sept. 15, 1930, II, 831.

Osteopoikilia or osteitis condensans generalisata is one of the rarest diseases of the skeleton. A case is described, showing a typical picture of generalized, small, sclerotic areas in the entire skeleton, but especially in the pelvic bones and the lower extremities. Clinical symptoms were not present.

H. W. HEFKE, M.D.

**A Case of Osteitis Fibrosa Cystica Generalisata.** Robert Kienböck and Emmerich Markovits. *Fortschr. a. d. Geb. d. Röntgenstr.*, June, 1930, XLI, 904.

Detailed history and extensive critical discussion of a case of Engel-Recklinghausen's disease (Engel, 1864, Recklinghausen, 1891), which showed several peculiarities, as follows: development during childhood; repeated progressive exacerbations; marked osteomalacic deformities; formation of large but not excessive expansive cysts and cyst-like areas; multiple spontaneous fractures; pronounced

pagetoid cranial changes; mild affection of the hands; progressive tendency towards aggravation. The duration at the time of report was fourteen years. A tumor of the parathyroid could not be detected by palpation, but its presence must nevertheless be assumed.

HANS A. JARRE, M.D.

Concerning the Unusual Changes in the Epiphyses of the Femora Described by Kreuz. Ernst Freund. *Fortschr. a. d. Geb. d. Röntgenstr.*, June, 1930, XLI, 935.

An unusual pathologic picture of hip pathology in a boy 15 years of age is reported. In both epiphyses of the femoral heads the upper shell was markedly changed, porotic, defective, and demarcated towards healthy portions of the bone by a rather wide band of sclerotic appearing bone. This, off-hand, could not be reconciled with the common diagnosis of a Perthes' disease, though all clinical symptoms were identical.

In the discussion of this case and the identical one reported by Kreuz, the opinion is substantiated that an aseptic necrosis occurred differing from the typical Perthes' disease only in extent, localization, and the mechanism of healing (reorganization). It is also mentioned that as a result of fractures through the femoral neck one may observe similar, wedge-shaped aseptic necroses, radiographically apparent as subchondral foci of destruction, with surrounding osteosclerosis.

HANS A. JARRE, M.D.

Some of the Deforming Bone Diseases of Adolescence. A. L. Gray. *Am. Jour. Roentgenol. and Rad. Ther.*, May, 1930, XXIII, 485.

The author discusses a group of allied bone diseases occurring in the latter half of the first decade and first portion of the second decade of life. Consideration is given to vertebral epiphysitis (Scheuermann's disease), separation of the epiphyseal head of the femur, osteochondritis deformans juvenilis coxæ (Legg-Perthes' disease), apophysitis of the anterior tibial tubercle (Osgood-Schlatter's disease), and osteochondritis of the tarsal

scaphoid (Köhler's disease). The author also describes a hip condition occurring in the same age period as Legg-Perthes' disease in which a broadening and softening of the acetabulum can be demonstrated, at times without changes in the femoral head, which he designates as acetabular Legg-Perthes' disease.

The combined factors of infections plus traumatism, resulting in localized deficiency of blood supply, are believed to be the etiologic factors.

J. E. HABBE, M.D.

## BONE TUMORS (THERAPY)

Giant-cell Bone Tumors: Four Cases Successfully Treated by Roentgen Rays. L. T. LeWald. *Medical Times*, August, 1930, LVIII, 232.

This condition is sometimes spoken of as osteitis fibrosa cystica, or bone cyst. The X-ray alone can be used with success in these cases. If surgery is employed, a simple curettement should be followed by X-ray therapy.

Four case reports are given with roentgenograms, in all of which cure was brought about by X-ray treatment alone. One case was curetted after a pathologic fracture, this being followed by X-ray treatment. The author considers this method preferable to surgery in giant-cell bone tumors.

W. W. WATKINS, M.D.

Giant-cell Tumors of Bone—A Clinical, Histological, and Radiotherapeutic Study. H. Lacharité. *Radiophysologie et Radiotherapie*, 1930, Vol. I, Fasc. IV, 535.

These tumors occur principally between the ages of 10 and 25 years. They attack chiefly the jaws and the epiphyses of the long bones. They are of slow development and do not give rise to metastasis or glandular involvement. They are, however, locally malignant and tend to recur after local removal. Macroscopically, they are dark colored, solid, and cystic growths, originating either from the perios-

teum or spongy tissue, while, microscopically, they are characterized by the presence of large numbers of multinucleated giant cells, regularly distributed throughout the growth. The importance of the biopsy in all cases is emphasized, and the author is of the opinion that any disadvantages of this procedure are outweighed by the advantages.

The results of radiation treatment in fourteen cases are recorded. Of these, eight were growths of the upper jaw, four of the lower jaw, one of the upper end of the humerus, and one of the cervical spine. Seven of these cases were post-operative recurrences. The technic of treatment varied greatly from case to case. Five cases were treated with radium, of which three were by interstitial methods, one by surface radium therapy, with moulded apparatus, and one by resection, followed by the insertion of a radium tube into the cavity. The filtration varied from 0.4 to 1.0 mm. of platinum, and the doses administered varied from 5.58 to 18.86 millicuries destroyed, given in one or more applications of from four to ten days each.

In nine cases, the X-ray was used. In these cases the voltage varied from 125 to 200 kilovolts, and the filtration from 5 mm. of Al to 2 mm. of Zn. The dose varied from 50 to 80 Holzknacht units over a period of from fifteen to forty-five days. In general, the doses were smaller than those employed in the treatment of carcinoma. Regression occurred as a result of the treatment in every case, but it was observed that a temporary increase in swelling and symptoms often preceded the regression. The temptation is to regard the treatment as having failed, and to operate during this stage. All the cases referred to in this paper are regarded as cured. The period since treatment is eight years in one case, seven years in four cases, six years in two cases, five years in one case, three years in three cases, and under three years in three cases. Post-operative recurrences give good results, but the response is slower than in primary cases. Incomplete operation followed by irradiation is condemned.

WALTER M. LEVITT, M.B., D.M.R.E.

**Congenital Exostoses and Their Transformation into Osteochondromas.** Mosenthal. *Röntgenpraxis*, August 15, 1935, II, 748.

Two patients (father and son) have been observed by the author, both showing multiple exostoses. In one case he could observe the origin and development of the exostoses into an osteochondroma, and in the other case he could see a very large tumor as the end result of such development. Therapeutically, only roentgen therapy offers anything. In two other cases of large chondroma of the pharynx, roentgen therapy led to liquefaction of the tumors and finally to a transformation of the chondromas into solid bone.

H. W. HUBB, M.D.

## CANCER (DIAGNOSIS)

**Organization and Efficiency in the Fight against Cancer of the Uterus.** Cl. Regaud. *Radiophysiologie et Radiotherapie*, 1930, Vol. II, Fasc. I, 81.

This paper is a reprint of Professor Regaud's report on this subject to the Cancer Sub-committee of the Section of Hygiene of the League of Nations.

The subject is discussed from three main standpoints: (1) Early diagnosis; (2) correct treatment, and (3) organization. As regards early diagnosis, emphasis is laid upon public instruction, increased facilities for special instruction of doctors and midwives, and above all, upon the importance of regular periodical examination. Every effort should be made to accustom the public to the idea of regular examination, and special gynecological diagnostic centers should be provided in every district. There is as yet no general agreement on the question of correct treatment, and only by very thorough organization of work, resulting in the production of irreproachable statistics, can such agreement eventually be achieved. As regards organization, while the necessity for early diagnosis demands widespread local facilities, the requirements for treatment are best met by the provision of

small number of highly specialized institutions possessing adequate radium supplies, powerful X-ray therapy apparatus, and highly competent staffs. The hiring of radium and the sale of radon to isolated practitioners lead to unsatisfactory results, and are to be discouraged.

WALTER M. LEVITT, M.B., D.M.R.E.

**Radiological Signs of Early Cancer of the Stomach.** Adelchi Salotti. *Minerva Medica*, May 19, 1930, XXI, 809.

A closer co-operation between the surgeon and the radiologist is advocated for a more exact radiologic technic in the diagnosis of cancer of the stomach in its early stages. The various morphological modifications which cancer may produce, namely, the infiltrating anomalies of the tissue, the vegetating protuberances of the gastric walls, and the ulcer cancer, result in radiographic images of different types. A series of radiographs is advised in each case, and different technics should be followed (Vallebona, Baastrup, Forssell), as the case might suggest.

The author includes a great number of radiographic illustrations, and discusses, in detail, the characteristics pertaining to neoplastic lesions as compared to those of non-malignant nature.

L. MARINELLI.

**On the Mechanism of Cancer Development.** Horst Oertel. *Canadian Med. Assn. Jour.*, August, 1930, XXIII, 183.

The author, who is Strathcona Professor of Pathology at McGill University, Montreal, sums up in this paper "the present state of our knowledge of cancer, as viewed from the standpoint and in the light of sober facts, purely as a scientific problem." He deals with the problem of the mechanism by which the cancerous or tumor change in tissues is initiated and executed.

He reaches these conclusions:

(1) The cancer cell is the expression of an atypical cell regeneration which results from continued disturbances in the normal relations between tissue cells, their vascular supply, and innervation. This brings about modifications

in the normal course of cell differentiation, its metabolic and formative functions, thus exhibiting shiftings from the normal, typical cell, and cell growth.

(2) It develops and grows on the basis of a general and organ disposition (metabolic peculiarities) in (a) the tissues of the host connected with the vascular supply, stroma, nerves, and in (b) the cancer cells themselves.

(3) The cancer cells, thus produced, are not open to those physiological environmental tissue influences which normally determine relative position and differentiation in new cells. Hence they grow as a new entity, with their own blood and nerve supply which are adapted only to their growth. The physiological, stationary, fully differentiated tissue is thus replaced wherever the atypical cancer cells grow, not by any particular aggression of the tumor cells, but by supersession of a new, actively growing tissue organization which is grafted on an old stationary one.

He concludes: "The tumor problem, like any other scientific problem, cannot be solved by shots in the dark, by spectacular discoveries, by fantastic ideas, or by a desire to find a cure by 'killing the cancer cells,' but by the sober, necessarily slow, intensive penetration into the laws which govern growth, because the tumor problem is a problem of growth. . . . When we know exactly the terms and mechanical steps of growth the 'tumor problem' will be within reach of our understanding."

L. J. CARTER, M.D.

**The Rôle of X-ray in the Diagnosis of Carcinoma of the Colon.** L. B. Morrison. *New England Jour. Med.*, Sept. 4, 1930, CCIII, 441.

There are two methods of X-ray examination of the colon; the barium meal by mouth gives a study of the movement of food through the colon; the barium enema shows the complete filling of the colon, with its internal outline when distended, and is by far the most satisfactory method. In either case the X-ray is simply a shadow study which depicts the outline of the colonic cavity, its

varying peristaltic movements and positions. The patient should be properly prepared for a barium enema by oil and a cleansing enema. A large rectal tube with three openings is preferred; this is inserted just past the internal sphincter, the barium mixture is made thin and the container is kept about twenty inches above the patient. The filling of the colon should be watched under the fluoroscope. The common types of carcinoma found in the colon are the medullary, colloid, and scirrhous or a combination of these. They occur most frequently in the male between the ages of fifty and sixty. The medullary and colloid types are ulcerating and found more frequently in the proximal colon. The scirrhous type is slow-growing and tends to obstruct, and is found most frequently in the flexures, the descending colon, and the sigmoid. The enema shows a filling defect in the ulcerative types, or meets obstruction at the site of the lesion in the obstructive type. Carcinoma must be differentiated from colitis, simple or ulcerative, diverticulitis, chronic constipation. A great majority of patients come for X-ray examination after a partial obstruction has taken place and in this condition a significant observation is that the bowel proximal to the lesion is filled with large masses of fecal material and somewhat distended with gas, while distal to the lesion, the bowel is usually empty. Often there are recurrent attacks of diarrhea in which the amount of the movement is very unsatisfactory.

W. W. WATKINS, M.D.

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Notes on the Pathology of Primary Carcinoma of the Lung. William Boyd. Canadian Med. Assn. Jour., August, 1930, XXIII, 210.

The author, who is Professor of Pathology in the University of Manitoba, Winnipeg, analyzed 14 cases of primary carcinoma of the lung met with in 900 autopsies in the Winnipeg General Hospital, together with 9 additional cases.

A study of the combined material has brought to light a number of unexpected facts,

some of which are at variance with the generally accepted teaching.

While the sex incidence is usually given as 3 males to 1 female, there was not a female in the 14 autopsied cases.

The conclusions arrived at by the author are as follows: (1) Part of the reported increase in primary carcinoma of the lung is to be attributed to the fact that many cases formerly diagnosed as sarcoma and lymphosarcoma are now regarded as carcinoma; (2) The sex incidence of the disease is very marked; (3) There is little evidence in support of the view that the inhalation of the exhaust gases from automobiles, or the tar from tarred roads, is a factor of any etiological importance; (4) One of the most common and important forms of lung cancer is the undifferentiated or anaplastic type, which was formerly regarded as a sarcoma; (5) All forms display a great tendency to invade the blood vessels and thus spread to distant organs; (6) Of these organs, the liver, brain, kidney, and adrenals are among the most frequently attacked; (7) Silver staining is of value in demonstrating the essential carcinomatous character of even the most anaplastic forms.

L. J. CARTER, M.D.

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A Contribution to the Diagnosis of Carcinomatous Pulmonary Lymphangitis. Ernst Lucas and Herbert Pollack. Fortschr. a. d. Geb. d. Röntgenstr., June, 1930, XLI, 865.

Carcinomatous pulmonary lymphangitis is not as rare as is generally assumed. It is represented by a peculiar accentuation of pulmonary markings resembling a diffuse, rather sharply contoured honey-combing, which may include pinhead-sized spots in its meshwork. As one cannot differentiate in any normal chest picture between the vascular markings cast by arteries, veins, and lymphatic vessels, all of which combined produce most of the linear pulmonary markings, one must consider for differential diagnosis all types of pathology liable to produce exaggeration of these markings: cardiac insufficiency, with stasis and congestion in the pulmonary circulation;



congenital dilatation of the pulmonary artery and its branches; hyperemia during infections and associated with polycythemia; furthermore, chronic bronchitis, pneumoconiosis, chronic tuberculous induration. A good history will help considerably with a differential diagnosis. However, in all cardiovascular cases one will be able to detect signs of congestion and edema, while infections, especially pneumoconiosis with chronic bronchitis, and tuberculosis, will be unevenly distributed and show initial foci. Most patients are referred with a diagnosis of tuberculosis or chronic bronchitis. While the majority cite complaints referable to the latter, some patients may not have any pulmonary symptoms at all.

Four cases are reported: (1) One arising from a carcinoma of the prostate, with bone metastases; (2) one from a penny-sized scirrhous of the stomach, duration apparently five years, complicated by syphilis; (3) the third spreading from a bronchial carcinoma, primary focus detected only at autopsy—apparently bronchoscopy is not a standard procedure in this hospital; (4) the fourth, without autoptic proof, associated with a large carcinoma of the stomach.

HANS A. JARRE, M.D.

### CANCER (THERAPY)

The Results of Radiotherapy in Adenocarcinoma of the Uterus. A. Lacassagne. *Radiophysiologie et Radiotherapie*, 1930, Vol. II, Fasc. I, 133.

The diagnosis of carcinoma of the body of the uterus is difficult clinically, and even when fragments removed by curettement are submitted to the microscope, a positive diagnosis is often not made. The author records the results of radiation treatment in thirty cases of carcinoma of the body of the uterus, in which the microscopical characters of the growths corresponded with the classical description of adenocarcinoma. Of these cases, eighteen were treated by intracavitary radium, four by X-rays, two by X-rays in combination with radium, and six by intracavitary,

combined with transcutaneous, radium. Details of the technic are not given. Of the thirty patients treated, three died of infective complications during or shortly after treatment; seven were improved, and five became free from signs of the disease and remained well. The interval since the treatment in the five well cases is eight years in one, and from two to three years in the others.

The author concludes that, in view of the fact that the results are much inferior to those obtained in carcinoma of the cervix, in the present state of knowledge operation is to be preferred to irradiation in the treatment of carcinoma of the body of the uterus.

WALTER M. LEVITT, M.B., D.M.R.E.

Radiotherapy of Carcinoma of the Uterine Cervix at the Radium Institute of Paris. A. Lacassagne. *Radiophysiologie et Radiotherapie*, 1930, Vol. II, Fasc. I, 95.

An investigation has been in progress since 1919, at the Radium Institute of Paris, on the radiation treatment of carcinoma of the cervix. Until 1920, emanation was exclusively used, in powerful foci and with relatively light filtration. The duration of treatment was short, usually one to three days, and the total dose comparatively small, rarely greater than 2,600 mg.-hours. In certain hypertrophic growths, needles or seeds were inserted into the growth. Radium puncture, whether by needles or seeds, was given up in 1922. High powered, deep therapy apparatus was installed in 1921, increased to eight in 1927. The technic of the local radium treatment was standardized in 1923, and has since remained unchanged. Six tubes are used, each of 15 mm. active length. Of these, four contain 13.33 mg. each of radium element, and two contain 6.66 mg. each. The filtration is never less than 1 mm. of platinum. Three tubes, enveloped in rubber, are placed end-to-end in the uterine canal (two of 13.33 mg. and one of 6.66 mg.). Two tubes, each of 13.33 mg., are placed in the fornices and held apart by a spring. The sixth tube, of 6.66 mg., is placed centrally at the upper end of the vagina. The

average duration of the treatment is five days, continuously. Sepsis is treated before the insertion of the radium. In the case of localized growths, no further treatment is given, but in more advanced growths, great importance is attached to the combination of the radium treatment with deep X-ray therapy. Adenocarcinoma and recurrences after the above treatment are dealt with surgically.

In all, 350 cases have been treated, of which 38 were in Stage I, 132 in Stage II, 149 in Stage III, and 31 in Stage IV. The percentage of five-year cures is given as 42 per cent for Stage I, 28 per cent for Stage II, 10 per cent for Stage III, and 0 per cent for Stage IV. The total five-year-cure rate is 20 per cent. Since 1924, a certain number of cases have been treated by telecurietherapy, with a four-gram bomb, in addition to the radium locally. This method of treatment and deep X-ray therapy are considered as alternative methods.

WALTER M. LEVITT, M.B., D.M.R.E.

**Systemic Changes in Patients with Carcinoma of the Uterus Following Roentgen and Radium Treatment.** E. O. Gaessler. *Strahlentherapie*, 1930, XXXVII, 361.

The author undertook extensive studies of the blood constituents in fifteen cases of uterine carcinoma before and after radium and X-ray treatment. It appeared that the irradiation produced an increase in the alkali reserve, an increase in the plasma volume, and of the total plasma protein. The changes in the fibrinogen, albumin, and globulin varied. The calcium in the blood is usually considerably increased following X-ray treatment. Fairly regular is the decrease of the cholesterol, of the surface tension, and of the fatty constituents of the blood. All these changes are only transitory. Radium treatment increases the plasma volume, sometimes the fibrinogen and globulin, but otherwise does not show any definite influence. The conclusion is reached that in carcinoma patients subjected to irradiation, an accurate study of all metabolic processes is essential, at least the alkali

reserve, the blood protein, the fats, cholesterol, potassium, and calcium should be studied. If, after an apparently clinical cure, these tests still show a deviation from the normal, the case should not be considered as cured but should receive further treatment.

ERNST A. POHLE, M.D., PH.D.

**A Study of the Microbial Flora of Carcinoma of the Cervix and Their Importance in Radiotherapy.** René Vincent and Octave Monod. *Radiophysiologie et Radiotherapie*, 1930, Vol. II, Fasc. I, 143.

The infecting organisms in carcinoma of the cervix are not constant, but the commonest is a hemolytic streptococcus. These infections are difficult ones with which to deal. Vaccine therapy, local and general, and serum therapy have all been tried, with only an occasional success in each case. Bacteriological examinations should, however, be carried out in all cases in which radiation treatment is contemplated, and in the presence of a hemolytic streptococcus one should proceed only with great caution.

WALTER M. LEVITT, M.B., D.M.R.E.

**Radical Treatment of Cancer of the Bladder.** Robert C. Coffey. *California and Western Med.*, August, 1930, XXXIII, 562.

The author gives his method of transplanting the ureters into the rectum. In the case of malignancy in the bladder—and then because the bladder becomes useless—it may be destroyed either by extensive surgery or by radium. Radium has an advantage in that it carries no mortality, and is especially useful in treating the region of the trigone.

Subtotal cystectomy in the male, for carcinoma located in the movable contractile portion of the bladder, should be ideal. In this way, the remaining base of the bladder and the urethra could be treated, and even destroyed with radium at the option of the operator, depending upon the case. Complete cystectomy in the female is by no means so difficult, and has been performed by the author in one case

following bilateral transplantation of the ureters, with perfect results. However, for cancer of the base of the bladder in women, even in operable cases, it may be possible that surgery may give no better results than destructive doses of radium, for in the female the base of the bladder may be treated through the anterior wall of the vagina, as well as from the inside of the bladder. For cancer of the movable part of the bladder in the female, subtotal cystectomy, or even total cystectomy, should be the procedure of choice.

It must not be forgotten, however, that the application of radium requires just the same skill and knowledge of cancer as does the application of surgery, if good results are to be obtained.

The author gives his procedure or plan of treatment with radium, using two or more 50 milligram tubes, filtered through brass and 1 millimeter of lead, spaced with a covering of gauze. This may be left in place for 36 hours. In this way, as much as five or six thousand milligram-hours may be used in the bladder.

F. B. SHELDON, M.D.

**Diseases of the Tongue.** H. C. Lindsay. *California and Western Med.*, October, 1930, XXXIII, 729.

Diseases of the tongue seem to have been somewhat neglected in our textbooks on dermatology. A simpler nomenclature and more definite descriptions would help the modern student in his studies of the buccal mucous membranes and of the tongue. Standardized nomenclature did much to simplify the study of dermatology, and standardized nomenclature could also be used advantageously to clarify the study of lingual maladies. Up to the present, naming diseases after their discoverers has not been overly indulged in.

The author has found that certain cases of leukoplakia lingualis respond to X-ray treatment, but believes radium is probably handier for this work and even more efficient. He discusses some of the fallacies in diagnosis, traumatic lesions of the tongue, and other confusing diseases of the mouth.

Under "Treatment," he says: "A word as to the treatment of carcinoma of the tongue.

Surgery undoubtedly has a definite value, but it seems to me that the result obtained by implants of radium seeds alone or in conjunction with surgical interference, excel in curative results those obtained by surgery alone. An interesting paper on this subject by Soiland, Costolow, and Meland appeared in the January issue of RADIOLOGY. Too much must not be expected from excision of the submental gland as an attempt to stop metastasis to the deeper cervical glands, because only some of the lymphatics from the tip of the tongue go through this gland and the channels from the posterior and middle third of the tongue do not.

"For some unexplained reason, roentgen-ray therapy does not seem to have been used much in treating diseases of the mucous membrane of the mouth. McKee expresses the belief that the mucosa will not stand X-rays well, although he states that he has not used them much for that purpose. On the other hand, Sabouraud is of the opposite opinion. I have used erythema doses of X-rays upon leukoplakia and non-malignant papillomata, with surprisingly satisfactory results. Smaller doses have greatly improved chronically inflamed and enlarged tongues, and they have been useful in reducing the hypersensitive, burning tongue which occasionally affects women during the menopause. Theoretically, X-rays should be helpful in treatment of the sensitive tongue in certain leukemic cases."

F. B. SHELDON, M.D.

**Cancer of the Breast.** Edmund S. Boice. *Southern Med. and Surg.*, August, 1930, XCII, 575.

Out of a total of 19,300 admissions to the Park View Hospital during the past 15 years, there were only 39 cases of cancer of the breast, and 54 patients with benign breast tumors. Radical breast operation was done upon 28 patients, and it is expected that not more than 25 per cent of these will reach the five-year limit without recurrence. Comment is made upon the statements of the American College of Surgeons as to the effects of radiotherapy upon the mortality figures, as con-

trasted with the experience of Pfahler. Quick, Lee and others in this country, and the author concludes that "certainly if their contentions are true it would appear that if we can get more patients to the surgeon in the stage when the microscope is necessary for diagnosis, and then treat these cases with the combination of radical operation and post-operative X-rays, we may reasonably expect a decided improvement over the results obtained in the past."

W. W. WATKINS, M.D.

**Intra-oral Cancer and its Treatment.**  
Albert Soiland and Orville N. Meland.  
California and Western Med., August, 1930,  
XXXIII, 559.

One of the most difficult problems of the physician is the recognition and treatment of intra-oral cancer. Patients are oftentimes seen with late lesions, due to difficulty in diagnosis because of the many pyogenic and pathologic processes which usually complicate the cancerous disease. This complication is serious because of the early extension through the dilated lymphatics into the regional lymph nodes. The authors speak of the complication with syphilis, and the methods of treatment used in the different clinics.

The technic which they have followed is given according to location. They feel that it is essential to render certain preliminary treatment prior to the institution of any active attack on the lesion. All forms of sepsis, due to teeth, must be eliminated by thorough dental cleansing and extraction. Likewise, plates must be permanently removed. Mild mouth washes give much relief. While this clean-up is being carried out, radiation in the form of high voltage X-ray or radium packs is given to the gland-bearing areas on each side of the neck. As a result of this preliminary treatment, enlarged glands, which are frequently only the seat of septic absorption, may disappear, while the original lesion in the mouth diminishes as the accompanying inflammatory zone shrinks.

When the primary lesion is on the tongue, it is attacked by circumvallation with implants

of radon, filtered through gold or platinum. Following the general rule of using 2.5 milluries per cubic centimeter of tissue, a reaction is set up that will destroy the malignant tissue without doing much damage to the normal structures. In case of doubt, it is better to over-radiate than to under-radiate, since the chances for a good result are better from the primary application than from subsequent sessions.

Lesions of the cheek may be treated by implants, but usually surface radiation, by gamma rays, will clear up the majority of the cases. If this is insufficient, the authors resort to electrocoagulation.

What to do with the regional glands is a moot question. Theoretically, a block dissection should be the procedure, but chances for cure after actual involvement of the glands are so small, and the mortality is so high, that it is not practised as often as formerly.

In the authors' work, where they palpate one or two movable glands and when these have not disappeared under irradiation, it is their procedure to expose the gland, destroy it by coagulation *in situ*, and then to apply a radium pack. The drawback is that the resulting wound heals very slowly. However, their impression is that in the few patients in whom they have done this, the shock from the operation is small and the immediate results are favorable. On the other hand, if the glands are fixed, external irradiation alone is given, with no attempt at surgical exposure.

When glass implants were introduced, the authors' enthusiasm increased, and now that interstitial irradiation from gold and platinum seeds is used, they feel that the patients with this disease have a fair chance for recovery. At any rate, the primary lesion practically always disappears. The prognosis of the case is dependent on the secondaries. Radiation, when successful, produces little deformity and does not interfere with function if the disease is not too extensive. Where radiation is not sufficient, especially in the radioresistant lesion, electrocoagulation and electrosurgery may be used with good effect.

F. B. SHELDON, M.D.

## THE CHEST (DIAGNOSIS)

The Radiologic Aspect of the Lungs and Valvular Defects of the Heart. Giovanni Balestra and Adolfo Ghio. *La Radiologia Medica*, June, 1930, XVII, 653.

The object of this article is the study of the relation between the diseases of the heart and the radiological appearance of the lungs. Roentgenograms of the chest do not supply sufficient factors in the diagnosis of organic affections of the heart, because they do not reveal their nature and cannot give any information as to the functional efficiency of the cardiac muscle itself. Radiologic control is considered very helpful, nevertheless, in functional defects of the left heart and mitral valves, because it may disclose evidence of pulmonary stasis which could not be noticed clinically.

The miliary shadows caused by pulmonary stasis may be sufficiently identified, especially on account of their position, to be definitely distinguished from miliary formations of tuberculous nature. Radiologic observation has, also, a special importance when the source (either pulmonary or circulatory) of hemoptysis is to be definitely ascertained.

L. MARINELLI.

Fibrinous Pneumonia, with Partial Lobar Consolidation. Manuel Viamonte. *Anales de Radiologia*, April, 1930, II, 61.

The author calls attention to and describes in detail an atypical modality of fibrinous pneumonia in which there is a triangular consolidation in the lower half of the right upper lobe, with the base towards the periphery. The process is found in adults and has the same roentgen characteristics as the initial period of lobar pneumonia in children, in which the consolidation is more pronounced at the periphery. These cases give a history of sudden onset, with high temperature and chills, and the illness is of short duration. The patients are not clinically ill after the crisis, even though the radiographic signs may persist. In one of the cases, total resolution did not take place

until two months after the crisis. These cases are usually diagnosed as bronchitis and "grippe" because of the absence or scarcity of physical signs; hence the importance of a radiological investigation in all cases with acute respiratory symptomatology, not only to determine the nature of the affection, but also to keep these patients under proper care in the post-crisis period, while roentgenologic signs are still in evidence, so as to prevent complications. The roentgenologic differential diagnosis is at times difficult, as tuberculous caseous pneumonia, primary parenchymatous carcinomata, and acute pulmonary abscess may also give triangular densities at the lower portion of the right upper lobe, with the base towards the periphery. The clinical, as well as the roentgenographic course of the illness, however, is much different in the caseous tuberculous pneumonia, where, when the evolution is favorable, the process runs from caseous to fibro-caseous, to fibrosis, there being no restitution to normal, as it happens in the uncomplicated fibrinous pneumonia. In the carcinomata, serial roentgenography will soon demonstrate the growth of the neoplasm. Finally, in pulmonary abscess, early cavitation is the rule.

(*Abstractor's note:* The author fails to enumerate intralobar empyema, which also gives a triangular shadow, with the base towards the periphery—a condition which is quite uncommon in tropical countries.)

P. R. CASELLAS, M.D.

Congenital Pneumothorax: Review of the Literature and Report of a Case. Jacob Stein. *Am. Jour. Dis. Child.*, July, 1930, 77, 89.

The author has carefully reviewed the literature and found four cases of congenital pneumothorax. He reports a fifth case. The earliest case was diagnosed at birth. In all of the four remaining cases, diagnosis was suggested on physical examination and confirmed by roentgenography.

Roentgenograms of the chest taken a few days after birth, showed the presence of lung marking in

The mediastinum and cardiac shadows were displaced to the left, and there was an adhesion in the right costophrenic space. A number of fluoroscopic examinations were made during the following two years, with practically no change in the roentgen findings, and a roentgenogram at the end of this period confirmed the fluoroscopic findings.

Two of the five patients died, one following pneumothorax and one with a diagnosis of broncho-pneumonia. Of the three living, treatment was attempted in only one case. Withdrawal of air was carried out but the lung collapsed after aspiration.

F. B. MANDEVILLE, M.D.

**The Lobus Venæ Azygos: Its Visibility on Roentgenologic Examination and its Significance for the Clinician.** Gustav Velde. *Fortschr. a. d. Geb. d. Röntgenstr.*, July, 1930, XLII, 82.

The author is of the opinion (the Abstractor thinks erroneously) that he first described this lobe as such in the roentgenologic literature. A perfectly normal interlobar septum may be demonstrated on roentgenograms of the chest. Occasionally a differentiation from tuberculosis, retrosternal thyroid, tumor, and pneumothorax must be made.

HANS A. JARRE, M.D.

**The Mechanism of Physical Signs in Neoplastic and Other Diseases of the Lung, with Especial Reference to Atelectasis and Emphysema.** Chevalier Jackson. *Jour. Am. Med. Assn.*, August 30, 1930, XCV, 639.

Bronchoscopic studies demonstrated, many years ago, the mechanism of the physical signs of foreign bodies in the bronchi. The understanding of this mechanism is essential for the proper interpretation of the physical signs. Removal of the foreign body and the consequent change in the physical signs made possible a rechecking and restudy of the previous interpretations. With the knowledge gained from this study, the study of the mechanism of the signs in disease was much sim-

plified. Bronchial obstruction is one of the fundamental factors in the etiology of pulmonary disease and in the production of physical signs.

Bronchoscopic observations have revealed three types of bronchial obstruction. Mechanically expressed they are: (1) a stop valve; (2) a check valve, and (3) a by-pass valve. In the stop-valve type, the bronchus is corked, and no air can get in or out. The residual air confined below is absorbed, and in a few hours atelectasis becomes demonstrable. After a variable period of time, drowned lung succeeds to the atelectasis because there are always at least a few organisms present in the bronchi. In the absence of lung ventilation the defensive powers of the lung are so diminished that suppuration quickly follows.

In check-valve obstruction a flow of air in only one direction may cause an obstructive atelectasis or an obstructive emphysema, according to the direction in which the valve operates. Emphysema and atelectasis may follow each other in quick succession, according to the action of the valve. The human thorax in its respiratory expansion and contraction simulates a bellows. Check-valve action in a bronchus may be of the ball-valve or the flapper-valve type.

In by-pass valve obstruction, the lumen is narrowed; air can pass in and out, but in diminished amount. The author lays stress on the "asthmatoïd wheeze" heard with the ear to the patient's mouth, and rarely audible at the chest wall, as an early evidence of obstruction.

Check-valve obstruction may be produced by: (1) foreign bodies; (2) benign growths; (3) malignant growths; (4) adenopathy; (5) anomaly; (6) inflammatory mucosal swelling; (7) granulations and granulomas; (8) secretions; (9) blood clots.

Differentiation between a non-opaque foreign body and an endogenous substance acting as such can be made only by the bronchoscope.

A detailed discussion of the conditions producing valvular obstruction includes new-growths, malignant growths, adenopathy, anomaly, inflammatory mucosal swelling,

granulations and granulomas, secretions, asthma, diphtheria, and blood clots.

Atelectasis in children is so often due to bronchoscopically curable valvular obstruction that the diagnosis of other types of atelectasis should not be made without bronchoscopy.

CHARLES G. SUTHERLAND, M.D.

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**The Roentgenologic Appearance of Lobular Pneumonia (Bronchopneumonia).**  
N. W. Potte. *Fortschr. a. d. Geb. d. Röntgenstr.*, July, 1930, XLII, 69.

The great variability of atelectasis, bronchopneumonia, hypostasis, pulmonary edema, tuberculosis (miliary) is discussed, and a correlation of the pathologic and roentgenologic appearances is attempted. Emphasis is laid upon the fact that a differential diagnosis may be arrived at only by proper correlation of all the clinical and roentgenologic information, and that there may be a considerable discrepancy between the histologic findings and the gross anatomic appearance. One should not neglect frequent re-examinations in such patients, as the changes in the films may lead to a correct diagnosis.

HANS A. JARRE, M.D.

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**Asbestosis Bodies in Sputum and Lung.**  
Kenneth M. Lynch and W. Atmar Smith. *Jour. Am. Med. Assn.*, August 30, 1930, XCV, 659.

Necropsies on patients who have been workers in asbestos mills over a prolonged period show certain peculiar foreign bodies in the alveoli, bronchioles, and interstitial fibrotic areas. These have been called "asbestosis bodies." There is a peculiar characteristic in the state of asbestosis, not found in silicosis. Patients show extensive fibrosis and "golden yellow" segmented structures, with rounded ends. Asbestosis bodies have been found in the sputum of patients who have been workers in asbestos; they were not found in the sputum of others.

It remains a subject for further study as to

the relation of the occurrence and duration of time of these bodies in the sputum to the extent of exposure to asbestos dust, and as to the state or stage of asbestosis or other associated conditions, in relation to their expulsion in the sputum. Asbestos bodies do not take the ordinary tissue and sputum dyes. They have been found in their natural form in a slide preparation of sputum stained by the ordinary method for tubercle bacilli.

CHARLES G. SUTHERLAND, M.D.

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**The Roentgen Appearance of the Chest of the New-born Infant.** John T. Farrell, Jr. *Am. Jour. Roentgenol. and Rad. Ther.*, August, 1930, XXIV, 140.

The author presents an illustrated roentgen study of 119 new-born infants, who were roentgenographed within 48 hours of birth, again ten days later, and some when six months of age. The spine of the new-born infant, in the lateral projection, does not have the familiar convex thoracic and concave lumbar curves. The sternum is seen more clearly in this view because of its form, and oftentimes presents five separate centers of ossification. The films of 96 infants were measured. The width was determined by measuring a line drawn at right-angles to the spine through the highest point of the diaphragm, and the internal measurement recorded. For the length, a second line was drawn through the center of the spine at right-angles to this first line, and the distance from the diaphragmatic line to the upper border of the first rib recorded as the length. The average thoracic width was 9 centimeters; the males were slightly larger than the females. The average length was 5 centimeters, the males again being slightly larger than the females. The transverse diameter of the heart was determined by measuring the distance it extended to the right and left by lines drawn at right-angles to the spine. It measured 5 centimeters in all cases. Four distinct conformations of the heart were noted: (1) the long narrow; (2) the broad apical, with narrow base; (3)

the broad apical, with broad base; (4) the round globular. In 30 instances the thymus was seen. Re-study at ten days of age showed no appreciable change in measurements. Re-study after a lapse of 6 months showed a similarity in the configuration of the thorax and thoracic organs to that seen in the same infant at birth.

J. E. HABBE, M.D.

**Posterior Mediastinal Empyema Perforating into a Bronchus.** Quintino Vischia. *Archivio di Radiologia*, May-June, 1930, VI, 485.

The author reports a case of probable empyema of the posterior mediastinum which had perforated a bronchus and produced expectoration of fetid pus. He also discusses the clinical and radiologic findings in such a lesion, and reviews the literature.

E. T. LEDDY, M.D.

## CONTRAST MEDIA

**The Roentgenologic Demonstration of the Mucosa by Means of Umbrathor: A Contribution to the Roentgenologic Diagnosis of Ulcerative Colitis.** H. Regelsberger. *Röntgenpraxis*, Oct. 1, 1930, II, 876.

The examination of the mucosa relief has added new diagnostic possibilities. A small amount of barium in the stomach, with a certain amount of compression, has been advocated by H. Berg. A perfect emulsion of barium cannot be made, which fact prohibits a uniform result. Recently a thoriumdioxyd preparation, called "Umbrathor," has been manufactured, which is a perfect colloidal emulsion. It is non-toxic and coats the mucosa in a thin, even layer. The combination of umbrathor with the instillation of air gives the best results. In demonstrating the mucosa of the colon, it offers more help than a barium enema or a barium enema combined with air inflation (A. W. Fischer). From 20 to 30 c.c.

of umbrathor seems sufficient to demonstrate the mucosa of the stomach.

H. W. HAKE, M.D.

**Clinical Use of "Lienography," a New Method for the Roentgenologic Demonstration of the Spleen and Liver.** Mitsutomo Oka. *Fortschr. a. d. Geb. d. Röntgenstr.*, June, 1930, XLI, 892.

Intravenously injected colloids of metals, with a negative charge, are accumulated in the reticulo-endothelial organs. While a large amount of colloidal thorium injected in a single dose produces shock and death, the repeated injection of small doses is relatively harmless. Thus in animal experimentation, merely slight variations in blood counts, formation of certain immune bodies, osmotic resistance, etc., were found during short periods.

Six patients received from 0.07 to 0.15 gram of thorium-dioxyd-sol in 10 per cent solution and mixed with 10 per cent glucose, subdivided into from six to eight doses on alternating days. The spleen and later also the liver cast radiopaque shadows at examination twenty-four hours following the injections. After-effects, fever, diarrhea, etc., were either mild or absent.

HANS A. JARRE, M.D.

**The Technic of the Intratracheal Injection of Iodized Oil.** Jerome R. Head. *Illinois Med. Jour.*, July, 1930, LVII, 73.

The writer uses a modification of the transglottic method of Rosenthal. Local anesthesia is unnecessary, and if the oil is heated it can be injected with an ordinary syringe through an eighteen or twenty gauge needle. The procedure is as follows: the oil, usually 20 c.c., is poured into the syringe and heated by revolving the barrel over a Bunsen or alcohol flame. With a little experience one can tell when the viscosity is sufficiently decreased. The needle is then fitted to the syringe. The patient is asked to refrain from swallowing or coughing during the injection. The cricoid



cartilage is located with the forefinger of the left hand and the needle inserted through the skin in the mid-line just at the upper border of the cricoid. This procedure is simplified if the skin is picked up and drawn away from the underlying tissues. With the needle already through the skin, the cricoid is again located with the finger and the needle pushed through the cricothyroid membrane by slipping it over the upper border of the cricoid. The accuracy of the puncture being verified by aspirating air into the syringe, the oil is injected. The needle should just enter the lumen of the trachea.

If one desires to examine a lower lobe, the patient is placed, sitting, on a chair facing the operator, leaning toward the side to be injected. If a middle or upper lobe is to be filled, injection is made while the patient lies on the affected side. To fill the upper lobe, he is tipped with the head downward, immediately after the injection. During injection in the recumbent position, it is necessary to have an assistant hold the head flexed to the upper side, so that the oil will flow downward into the lung. Ten c.c. of oil will give a satisfactory visualization of a single lobe in an adult, and five c.c. in a child.

C. H. DEWITT, M.D.

### ESOPHAGUS (DIAGNOSIS)

A New Technic for the Radiological Study of the Stenotic Affections of the Esophagus. Giuliano Chizzola. *La Radiologia Medica*, April, 1930, XVII, 403.

The classical technic employed in the radiologic examination of the esophagus is wholly inadequate if the shape of a stenosis is to be ascertained.

The ingenuous artifice of Ledoux and Sluys accomplishes its purpose in most cases but it presents inconveniences of a practical nature. The author has devised and applied for some time, a personal method with very satisfactory results. The procedure is as follows:

First of all the location and the approximate extent of the lesion must be studied with the ordinary technic. The patient is then given

the classical Rivière's potion in order to create formation of gas in his stomach. This is to be followed quickly by the administration of some viscous opaque meal, not too thick, in order that it may pass through the stenotic region. As soon as the stenosis is perceived on the screen, an additional opaque meal is given; this time it must be thick so that it may produce a lasting image on the upper limit of the lesion. In the meantime, some of the gas in the stomach will have forced its way out through the cardia and inflated the substenotic portion of the esophagus. The stenosis would thus be limited by positive and negative images.

L. MARINELLI.

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Diverticula of the Thoracic Portion of the Esophagus. C. H. Heacock. *Southern Med. Jour.*, June, 1930, XXIII, 517.

Prior to the advent of the X-ray, with one or two exceptions, diverticula of the thoracic portion of the esophagus were found only at postmortem examinations. Since 1898 nearly all the cases reported in the literature have been discovered during roentgen examination, which usually gives all the information necessary, and, frequently, even the type of diverticulum may be determined. Traction diverticula are usually more or less cone-shaped, with the bases toward the lumen. Pulsion diverticula usually have rounded or oval contours and are constricted at the bases.

One of the cases reported had multiple diverticula. Two case histories are cited.

W. W. WATKINS, M.D.

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Epibronchial Diverticulum of the Esophagus in a Patient Affected by Gastric Neoplasm. Mario Muzii. *La Radiologia Medica*, July, 1930, XVII, 802.

The author reviews the current literature on the etiology of diverticulum of the esophagus, pointing out its clinical symptoms and describing its radiological appearance. The radiological diagnosis does not present any great difficulty, provided that the observations are car-

ried out in a certain way and with proper care. The author describes a case personally observed, in which an esophageal diverticulum did not present any clinical symptoms; the patient had, however, a gastric tumor.

L. MARINELLI.

### GALL BLADDER (NORMAL AND PATHOLOGICAL)

Biliary Colic in Routine Cholecystography. Irving Gray and Milton J. Matzner. Long Island Med. Jour., August, 1930, XXIV, 440.

Following the introduction of cholecystography, the use of the fat-rich diet as a test for the functional ability of the gall bladder to empty itself has become a routine. Within the past eight months, during routine cholecystographic examination, four patients have developed pain in the right upper abdomen following the ingestion of a fat-rich diet, the attacks coming on in from fifteen to forty-five minutes. This occurrence is proof of the danger of using too high a fat diet as a routine, without individual indications. If distress should occur, even if normal cystographic findings are noted, gall-bladder disease may be strongly suspected.

W. W. WATKINS, M.D.

The Blood Supply of the Gall Bladder. Anastasia Rubascheva. Fortschr. a. d. Geb. d. Röntgenstr., June, 1930, XLI, 957.

This paper presents a study of the cystic artery of the dog, the rabbit, and man by radiopaque injection, showing its great morphologic variability and the multiplicity of the arterial supply of the ductus choledochus.

H. A. JARRE, M.D.

The Effect of Acute Experimental Cholecystitis on the Emptying of the Gall Bladder. George T. Murphy. Arch. Surg., August, 1930, XXI, 300.

Acutely inflamed gall bladders were produced in ten dogs by the intravenous injection

of varying amounts of esol. The effect of the specific chemical cholecystitis on the emptying of the gall bladder was studied in a series of ten animals. Direct observations, as well as roentgenograms, were made of the diseased gall bladders following the administration of a meal rich in egg yolk and cream. Only one instance has been encountered wherein an acutely inflamed gall bladder, produced by this means, has shown any evidence of emptying. The observations appear to indicate that the acutely inflamed gall bladder does not empty after the usual test meal.

HOWARD P. DOUB, M.D.

### GASTRO-INTESTINAL TRACT (DIAGNOSIS)

Segmentary Toxic Gastritis of the Antrum Pylori. Lorenzo Giuntoli. La Radiologia Medica, July, 1930, XVII, 853.

This is a report of a radiological examination of a subject who swallowed a 20 per cent solution of sulphuric acid. X-ray investigation revealed a total pyloric stenosis. At operation the surgeon could not find any other lesion and performed a simple posterior gastro-enterostomy. The author ascribes the location of the lesion to the long stay of the caustic solution in the antrum. This delay is thought to have been caused by irregular changes in peristalsis, brought about under the stimulus of an hyperacid content.

L. MARINELLI.

An Appraisal of the Motor-test-meal in the Roentgen Examination of the Stomach and Small Bowel. Alexander B. Moore. Am. Jour. Roentgenol. and Rad. Ther., May, 1930, XXIII, 503.

The three common causes of six-hour gastric retention of the barium meal are: gastric cancer, gastric ulcer, and duodenal ulcer. In a series of 950 cases examined and later operated on at the Mayo Clinic, 60 per cent of gastric cancers, 45 per cent of gastric ulcers, and 28 per cent of duodenal ulcers showed some gastric retention. Rarer organic

causes of six-hour retention are: pyloric ring ulcer, pyloric muscle hypertrophy, congenital pyloric stenosis, adhesions about the duodenum, benign pedunculated tumors, cancer or ulcer in the upper jejunum, and gastro-jejunal ulcer.

Non-organic causes of stasis are: (1) severe migraine; (2) dread of the examination; (3) habitual use of morphine; (4) tabes dorsalis; (5) irritation following gastric analysis; (6) hypotonic stomach; (7) cholecystitis; (8) chronic appendicitis, and (9) the taking of food during the six-hour interval. The author lists seven points indicating the value of a six-hour retention but offsets these with eight points arguing against its intrinsic worth and closes with a statement that since discontinuing the six-hour motor meal examination at the Mayo Clinic the accuracy of diagnosis has been slightly increased.

J. E. HABBE, M.D.

**Importance of Radiological Control on Duodenal Drainage.** Giuliano Chizzola. *Minerva Medica*, June 2, 1930, XXI, 918.

The author discusses the difficulties encountered in the correct performance of the Meltzer-Lyon test, used in the study of biliary diseases.

It is important for the physician to know the path followed by the bulb of the apparatus and its final position. Indirect evidence is to be discarded as misleading, and ordinary radiography may not be satisfactory. The author proposes a topographical localization of the bulb by injecting air through the tube into the duodenum by means of a Paquelin pump. He shows, with radiographic films, how definite information is obtained by this method, and suggests that it be adopted in routine practice because it is simple and innocuous.

L. MARINELLI.

**Stenosis of the Submesocolic Portion of the Duodenum.** Vito Potenza. *La Radiologia Medica*, June, 1930, XVII, 675.

The author has observed a submesocolic periduodenitis in a child three and a half years old. The symptoms, which had been noticed

since birth, were temporarily and partially relieved by a lactic-hydro-alkaline diet.

The operative findings fully confirmed the radiological diagnosis. Peritoneal adhesions in the third portion of the duodenum and superficial ligaments between the gall bladder and the lower surface of the liver were found. The patient has fully recovered following a posterior gastro-enterostomy. The radiological picture was that classically described by Holzknecht, and it was thought worth publishing because of the rarity of the anomaly and of the marked alterations revealed, and because it demonstrates the aid radiology may supply in the diagnosis of disturbances of young patients.

L. MARINELLI.

**The Radiological Diagnosis of Duodenal Ulcer.** Alberto Anzillotti. *Minerva Medica*, Sept. 8, 1930, XXI, 331.

The author replies to the criticism some writers have voiced against the use of fluoroscopy in the diagnosis of duodenal ulcer. He supports the value of the indirect factors, and considers radiosopic investigation quite sufficient in most cases.

L. MARINELLI.

**The Human Constitution in its Relation to Gastro-intestinal Disorders.** Julius Friedenwald. *Jour. Am. Med. Assn.*, Sept. 27, 1930, XCV, 905.

It has now become well established that not only do internal conditions bear a direct influence in the production and the course of disease, but the inherent characteristics of the tissues of the body themselves and their resistance and reactions to these influences likewise play an important rôle in this respect.

Draper directs attention to the individual's personality, and Raymond Pearl has directed two lines of research. In Pearl's first research, a series of family records have been subjected to various forms of genetic and statistical analysis. The second approach has been through the biometric study of autopsy records.

It is quite possible that by means of a more intensive study of the human constitution certain diseases may become recognized far ear-

liver and their progress arrested before serious inroads have been made into the patient's health. The author limits his remarks to this relation with the gastro-intestinal tract.

Congenital abnormalities of the mouth, tongue, esophagus, stomach, and intestines are discussed, and attempts made to correlate roentgenologic observations with gastric motility and general physique of the individual.

Mills' study of the relation of bodily habitus to visceral form, position, tonus, and other studies are reviewed to emphasize the importance of a better understanding of the human constitution in its relation to diseases of the gastro-intestinal tract.

CHARLES G. SUTHERLAND, M.D.

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**The Radiological Aspects of Duodenal Mobility.** Virgilio Dall'Acqua. *La Radiologia Medica*, July, 1930, XVII, 781.

According to the most recent statistics the occurrence of duodenal mobility is not rare, being of the order of above 0.5 of 1 per cent of all cases radiologically studied. Its detection is not always easy, and its interpretation not always exact.

The author illustrates seven cases studied in the course of a year. He distinguishes the different forms of this anomaly as follows: (1) Partial mobility, which affects only the first part of the duodenum and the beginning of the second; (2) total mobility, which involves the entire duodenal area. In the first case the duodenum presents, radiologically, an image similar to a double festoon, or else it may form a complete arc above the fixed portion of the descending tract. If the latter is free, the duodenum appears capsized, that is, open from below. This abnormality occurs when, in addition to mobility, other factors such as stretching of the hepatoduodenal ligament or ptosis of the liver are present. The diagnosis of total mobility is generally difficult. In the majority of cases, however, the duodenum appears all on one side of the vertical axis of the body, and it causes abnormal arrangement of the abdominal viscera. A case is described in which, besides duodenal mobility, there was inversion of the stomach and

liver, with persistence of the mesenterium commune, and mobility of the cecum.

As for the importance this anomaly may have in abdominal pathology, it must not be forgotten that, while it may in some cases occur symptomatically, in others it may cause duodenal stenosis and compression of the bile ducts.

Gastritis, duodenitis, periduodenitis, gastric or duodenal ulcers may frequently be caused by the anomaly in question.

L. MARINELLI.

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**Hypertrophic Pyloric Stenosis in Adults: Roentgen Aspects.** Vincent W. Archer. *Am. Jour. Roentgenol. and Rad. Ther.*, May, 1930, XXIII, 510.

The author believes hypertrophic pyloric stenosis to be a definite disease entity, with a definite syndrome. Two explanations for the condition are, a long continued functional spasm resulting in hypertrophy of a previously normal pylorus, and an hypertrophy of the congenital type, which for years may have been overcome, with symptoms recurring later in life. The author's three cases, showing only benign hypertrophy of the pylorus, varied in age from 39 to 63, each presenting symptoms suggestive of either ulcer or carcinoma. It is believed that the hypertrophic stenosis, when marked, can be differentiated roentgenologically from simple pylorospasm by careful roentgenoscopic study, the two significant findings being a persistent unchanging increase in breadth of the pyloric ring not amenable to anti-spasmodics, and a six-hour gastric residue.

J. E. HABBE, M.D.

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**Diagnosis and Therapy of Acute Necrosis of the Pancreas.** R. Ehrmann. *Med. Klinik*, Sept. 12, 1930, XXVI, No. 37, p. 1363.

The roentgenologic symptoms of an acute necrosis of the pancreas have not been thought of often enough. Slight lagging of the left diaphragm, and changes in the outline of the stomach and duodenum, which are caused by an enlarged pancreas, have been described.

The author regularly found such a change in the contour of the outline of the stomach. The duodenum may also be displaced. One may often find a rather large, soft-tissue tumor in the pancreatic region on a flat film of the abdomen, which represents the greatly enlarged, edematous pancreas. The roentgenologic examination may be of great help in such cases, in which the clinical diagnosis is often exceedingly difficult.

H. W. HEFKE, M.D.

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**Radiological Aid in the Study of Chronic Colitis.** Antonio Gavazzeni. *La Radiologia Medica*, April, 1930, XVII, 433.

The author studied thirty cases of chronic colitis. He admits that this disease does not present, radiologically, any characteristic signs, but he shows, however, that in cases with ambiguous clinical symptoms the latter are not to be held negligible as aids, especially in myxomembranous and ulcerative colitis involving the mobility and morphology of the colon. Radiological study is considered valuable in the diagnosis of functional troubles. In some cases it is almost necessary in order to localize and evaluate the affection.

L. MARINELLI.

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**Clinical Syndromes that Include Achlorhydria.** James S. McLester. *Jour. Am. Med. Assn.*, Sept. 6, 1930, XCV, 719.

A symptom complex is frequently seen in the South that is exhibited with striking uniformity by an apparently heterogeneous group of diseases, including an anemia of variable degree, sore tongue, gastro-intestinal disturbances, cord changes perhaps, and achlorhydria. Any one or any combination of these may dominate the whole and give color to the clinical picture, but achlorhydria is the one salient feature. It signalizes the group.

This has suggested pernicious anemia, pellagra, sprue, and subacute combined sclerosis, depending on the predominant symptom. What is the meaning of the central feature of the clinical picture, the achlorhydria? The problem is complicated by the fact that this gastric

deficiency may be experienced by apparently healthy persons with perfect digestion.

In Castle's discovery that muscle meats which have been partially digested in the normal stomach and then regurgitated will, when fed to a patient with pernicious anemia, bring about the same blood regeneration and amelioration of symptoms as would a diet of liver, an entirely new light is thrown on the problem.

Pernicious anemia (and probably sprue) is a deficiency disease due to the lack of two substances, an intrinsic and an extrinsic factor. Evidently the intrinsic factor is formed in the normal stomach. The extrinsic factor is probably a nitrogenous base, which can be produced from beef muscle through the action of the intrinsic factor.

A review of eight cases follows, and the author points out that the difficulty of categorically labeling these patients illustrates the possible kinship between the diseases of this group.

CHARLES G. SUTHERLAND, M.D.

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**Diagnosis of the Nature of Benign Growths of the Stomach.** Alberto Anzillotti. *La Radiologia Medica*, April, 1930, XVII, 455.

This is a report on three radiological observations of benign growths of the stomach. These neoplasms are very rare and it is often impossible to formulate a differential diagnosis, especially in stenotic cases presenting gastric ectasy (myoma of the pylorus).

The observations reported by the author were a myoma of the antrum pylori, a circular myoma of the pylorus, and a movable polypus of the stomach.

L. MARINELLI.

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**The Roentgen Diagnosis of Inflammatory Lesions of the Colon and Their Differentiation from Carcinomas.** H. Pansdorf. *Röntgenpraxis*, August 15, 1930, II, 732.

The roentgen examination of the colon allows us to-day to almost always make a differential diagnosis between inflammatory and malignant processes of the colon. Any

one of the three methods of colon examination, namely, the barium enema, the examination of the "mucosa-relief" with a collapsed colon, and the combination of barium and air-inflation is by itself not always sufficient to make a definite diagnosis. In practice, one should first examine the colon distended by a barium enema. After emptying, one may study the mucosa and finish with inflating the colon with air, according to A. W. Fischer's technic. A definite differential diagnosis in the greatest number of cases may then be established.

H. W. HERKE, M.D.

**The Alimentary Tract in Flajani-Basedow's Disease.** Pietro Ottonello. *Rivista di Radiologia e Fisica Medica*, August, 1930, II, 401.

In the X-ray examination of the gastro-intestinal tract of six patients with Flajani-Basedow's disease, the author noted an unusually rapid passage of the opaque meal, and insufficiency of the normal sphincters of the gut. He believes the cause is an excitation of the fibers of the vegetative nervous system by toxic substances from the thyroid, and on this basis he explains the marked loss of weight common in patients with this disease. In the presence of similar radiologic findings not explained by other facts, Ottonello is of the opinion that one should suspect an unrecognized case of Basedow's disease.

E. T. LEDDY, M.D.

**Evaluation of the X-ray Examination in Duodenal Ulcer.** Charles D. Enfield. *Am. Jour. Surg.*, September, 1930, IX, 465.

The author considers the question of etiology at length, and admits that there is no definite knowledge of a constant etiological factor, and there may be an underlying ulcer diathesis, the nature of which is as yet quite unknown.

He considers the various signs and symptoms of duodenal ulcer, and concludes that the X-ray diagnosis of duodenal ulcer is as nearly accurate as any diagnostic measure, when done by a competent and experienced radiologist. Inasmuch as duodenal ulcer practically

always occurs in the bulb, it follows that if the radiologist can satisfy himself that the bulb is of normal contour, ulcer may be excluded from the duodenum.

Spasm of the duodenal cap is often the most conspicuous part of the deformity, and to a considerable degree is a measure of the activity of the ulcer. The author believes that frequently the duodenum must be opened at the operating table in order to verify the roentgenologic diagnosis, as the surgeon cannot be sure by palpating the duodenal cap externally.

Formerly most of the roentgenologic diagnoses were based on the indirect signs, consisting of enlarged stomach, hypertonus, hyperperistalsis, and a considerable six-hour residue, coupled with inability to visualize a normal duodenal bulb, but of late the cases are being seen earlier and the diagnosis is made to a large extent on simple deformity of the duodenal bulb.

HOWARD P. DOUB, M.D.

**Colon Studies: VI.—Cecal Stasis: Its Clinical Significance and Relation to Proximal Colon Stasis.** John L. Kantor, Samuel Schechter, and Jerome A. Marks. *Am. Jour. Roentgenol. and Rad. Ther.*, July, 1930, XXIV, 1.

The authors define the various types of cecal and cecocolic stasis and non-stasis as follows: (1) Cecal and cecocolic non-stasis shows no "pocketing" at any time and the proximal colon is entirely empty within 48 hours after the ingestion of the barium meal; (2) cecal stasis shows cecal residue for at least 48 hours after the barium meal, with the adjacent colon empty; (3) 24-hour cecal stasis shows a residue persisting in the cecum for 24 hours only, with the adjacent colon empty; (4) secondary cecocolic stasis shows the cecocolon and also the transverse colon filled at 48 hours; (5) primary cecocolic stasis shows the cecocolon filled at 48 hours, but the transverse and distal colon empty; (6) 24-hour primary cecocolic stasis shows a 24-hour residue, with the transverse and distal colon empty.

Cecal and cecocolic stasis have been attributed to various causes, included in which

are pericolic, pericecal, hepatocolic adhesions, kinks or spasms of the hepatic flexure, ptosis of the transverse colon, intrinsic obstructive lesions, and exaggerated antiperistalsis.

While the absorption of toxins is considered as a possible explanation of symptoms, such as headache, vomiting, and a dragging sensation in the right lower abdomen, the authors lean toward the possibility of transient duodenal block from intermittent drag by the elongated cecocolon as a causative factor, particularly since symptoms are nearly twice as frequent in the low cecal group.

The incidence of cecal stasis was 27 per cent in 959 gastro-intestinal examinations, and the incidence was slightly higher in those upon whom an appendectomy had been performed. Cecocolic stasis was much less frequent, it being only 10 per cent when associated with constipation, and only 1 per cent when occurring alone. Both cecal and cecocolic stasis are in themselves of relatively minor importance, although in cases with low cecal symptoms they are much more common.

J. E. HABBE, M.D.

**The Roentgenologic Appearance of Diverticula of the Duodenum and of Structures Resembling Such Diverticuloids.** Robert Sandera. *Fortschr. a. d. Geb. d. Röntgenstr.*, July, 1930, XLII, 54.

There is no characteristic picture differentiating between true and false diverticula of the duodenum. Forssell's six points may be applied to both types, with a varying degree of accuracy. While a distinction between true and false diverticula cannot always be made, it may often be detected from careful roentgenologic exploration. The clinical picture of either type is not characteristic, as the types vary greatly with the location, the degree of stasis and accompanying obstruction, and the involvement of adjacent organs.

The paper is illustrated by the presentation of several cases, discussed in detail, as follows: Cholecystoduodenostomy; diverticulum simulated by traction of adhesions, and an in-

testinal loop projecting near the duodeno-jejunal junction; two true diverticula; one ectatic lateral recess of the bulb.

HANS A. JARRE, M.D.

**Roentgen Evidence of Adhesions of the Small Intestine.** Horace W. Soper and J. William Thompson. *Am. Jour. Surg.*, August, 1930, IX, 243.

The authors divide adhesions into three classes: (1) The usual adhesions that follow appendectomy. In this type the coils of the terminal ileum are matted together, but usually produce no symptoms. (2) One or more bands are formed which attach a coil of the gut to some neighboring organ or to the abdominal wall. This type may produce no symptoms, but it forms a trap that may catch a loop of the bowel and produce acute obstruction. A careful X-ray examination will often find atypical dilated coils. (3) These adhesions form definite bands which bind down the intestine and form a partial stenosis of the lumen and interfere with function. This type is more easily demonstrated by roentgen examination. The symptoms are usually dull pain located in the region of the constriction, intermittent in character, often nausea, and anorexia. A history of partial attacks of obstruction is usually obtained.

HOWARD P. DOUB, M.D.

**Concerning my Method for the Screen Examination of the Duodenum.** Nándor Ratkóczi. *Fortschr. a. d. Geb. d. Röntgenstr.*, June, 1930, XLI, 941.

The author emphasizes the advisability of visualizing the duodenal bulb in almost dextrosinistral position, while the stomach is displaced by a long distinator spoon.

HANS A. JARRE, M.D.

**Duodenal Fistula.** John J. Gilbride. *Jour. Am. Med. Assn.*, July 26, 1930, XCV, 259.

Two forms of fistula have been described, namely, an external and an internal duodenal fistula, the external being the more frequent. The internal duodenal fistula may occur between the duodenum and other abdominal

viscera. Rupture of the duodenum by indirect violence inflicted on the abdomen may result in a fistula; such is not a true internal fistula.

External duodenal fistula is caused by injury to the duodenum during the performance of surgical operations. Injury to the duodenum may occur during operation on the duodenum, the pyloric end of the stomach, the gall bladder, the liver, the hepatic flexure of the colon, or the right kidney. The injury is rarely recognized at the time of its occurrence, becoming apparent one to four days later. The fistula has made its appearance as late as ten days after operation (one such case is reported). The mortality rate ranges from 75 to 25 per cent. The difference in mortality is caused by the widely different characters of the duodenal secretion in respective groups. A higher rate prevails in cases associated with an active functioning duodenum, the duodenal and pancreatic secretions having a destructive effect on the tissues locally. The loss of these secretions and their component elements to the body is even more important.

CHARLES G. SUTHERLAND, M.D.

**Multiple Adenopapillomata of the Stomach, with Report of Case Showing Varying Degrees of Malignancy.** F. D. Ackman. Canadian Med. Assn. Jour., September, 1930, XXIII, 391.

Multiple polypoid adenomata of the stomach were first diagnosed clinically in 1909, although they had been recognized at post-mortem examination prior to that time. Since 1909, 39 proved cases have been reported, of which only 15 have been found on postmortem examination. Of the remaining 24 cases, 10 were diagnosed at operation, 9 by roentgenography, 3 by finding tumor tissue in the gastric washings, and 2 by gastroscopy. All of the 9 X-ray diagnoses have been made since 1919, when Balfour reported the first case to be diagnosed by this method. Of all methods of diagnosis the X-ray should be stressed, although the greatest difficulty is found with the borderline cases.

Treatment of the condition should be surgical on account of the danger of malignancy.

Partial resection of the stomach is the operation of choice.

A typically difficult case is reported from the author's service in the Montreal General Hospital. The only clinical symptom had been a severe hematemesis.

The X-ray report of Dr. Ritchie is as follows: "There is evidence of a constant filling defect in the greater curvature in the pars media, and towards the pyloric end of the stomach. There is some widening of the pyloric orifice, and in the cap of the duodenum there is an irregular filling. This latter condition is very suggestive of a papilloma which has passed through the pyloric orifice into the duodenum. There is no definite evidence of disease of the cap itself. The filling defect on the greater curvature, while suggestive of a malignant growth, might be due to a similar condition to that seen in the cap. However, the weight of evidence is more in favor of the former."

At operation a partial gastrectomy was done, and the recovery was uneventful. The post-operative diagnosis was multiple papillomata of the stomach, which had become malignant. One small polypus had extruded through the pyloric ring into the duodenum.

L. J. CARTER, M.D.

**A Case of Ileocolic Mesenterium Commune, without Rotation.** Giuseppe Sighinolfi. La Radiologia Medica, June, 1930, XVII, 734.

The author reviews briefly the most modern embryological theories on the normal development of Toldt's umbilical ansa, and on the pathogeny of intestinal rotation. He illustrates, using the iconographic material of Dott, the different embryogenetic periods, and the complex errors of evolutive impulses. He emphasizes the anatomic and clinico-radiological importance of the above-mentioned ontogenetic conceptions and describes, furthermore, the radiological observations in a case of ileocolic mesenterium commune which did not present rotation.

The pathogenesis of the gastro-intestinal syndrome offered by the patient is interpreted by the author on the grounds of a strict cor-



relation between morphologic anomaly and vagotonic system, having a purely functional origin.

L. MARINELLI.

### GENITO-URINARY TRACT (DIAGNOSIS)

**Uroselectan in Intravenous Urography.** Joseph Welfeld and Davis H. Pardoll. *Illinois Med. Jour.*, September, 1930, LVIII, 179.

This organic iodine compound has a selective affinity for the urinary tract, is non-irritating, and in normally functioning kidneys nearly 100 per cent is excreted at the end of 8 hours, the maximum concentration occurring about 30 minutes after the injection, and the greater amount being excreted during the first two hours.

The following dosage is recommended: Infants and young children: 20 c.c. of a 40 per cent solution. Children up to 6 years: 40 c.c. of a 40 per cent solution. Children up to 12 years: 60 c.c. of a 40 per cent solution. Adults: 100 c.c. of a 40 per cent solution.

Successful urography with uroselectan depends upon the ability of the renal parenchyma to excrete it. Visualization of the kidneys, ureters, and bladder is satisfactorily accomplished when the kidneys are able to excrete the drug.

In general, the contra-indications to the use of uroselectan are those of impaired renal function, and the following conditions are given: (1) hypoplasia; (2) advanced renal tumor; (3) pyonephrosis; (4) nephritis and severe nephrosis; (5) severely infected occluded kidney; (6) complete urinary retention; (7) severe cardiac insufficiency; (8) prostatic hypertrophy, with severe degree of infection and retention; (9) where instrumentation or medication is desirable, as well as interpretation of function and pyelography.

The writers find it unnecessary to divide the dose if 15 to 30 minutes are allowed for the injection.

In conclusion, the authors summarize as follows: "We wish to state that we believe

uroselectan to be a marked advance in the armamentarium of urologists for aiding diagnosis in certain selected cases, but hardly feel that the future of urology will be relegated to the X-ray laboratory, nor that the procedure of pyelography has become so difficult that the introduction of uroselectan will automatically displace direct pyelo-ureterography."

C. H. DEWITT, M.D.

**The Pyelographic Image after the Injection of Uroselectan.** Luigi Turano. *Archivio di Radiologia*, May-June, 1930, VI, 503.

The author reports ten cases studied by this new method, points out its advantages, shows that a scrupulously careful technic is necessary in its use, and believes that by this method valuable data on the morphologic relationships of the urinary tract may be obtained.

E. T. LEDDY, M.D.

**Examination of the Urinary Ducts, with a New Substance Intravenously Injected.** Dino Tartagli. *La Radiologia Medica*, July, 1930, XVII, 781.

This is a study of the efficacy of uroselectan in pyelography. The author explains the technic followed in preparing the solution, in administering it, and in taking radiographs. He compares this method with others already practised, and expresses himself very favorable to its use.

L. MARINELLI.

**Intravenous Urography.** Fletcher H. Colby. *New England Jour. Med.*, Sept. 4, 1930, CCIII, 470.

Visualization of the urinary tract by means of intravenous injection has become an established procedure. The administration and dosage of uroselectan are simple. Forty grams of the drug are dissolved in 100 c.c. of redistilled water, filtered and sterilized; the entire amount is injected slowly into a forearm vein. Children and infants are given correspondingly smaller doses. The drug is of low toxicity, and since 90 per cent of it is

eliminated by the kidneys, the amount recovered in the urine in a given length of time can serve as a functional kidney test. With good kidney function, from 15 to 16 grams of iodine will be eliminated in the first two hours after injection. The method should not replace the usual pyelography but can be used in cases in which, for various reasons, it is not possible to use cystoscopy, or in which obstruction prevents the introduction of the pyelographic medium, or the instrumental method is risky for the patient, or in cases in which we do not wish to use pyelography and can obtain sufficient information by means of the intravenous method.

W. W. WATKINS, M.D.

**Anomalies of the Genito-urinary Tract.**  
A. C. Abbott. *Canadian Med. Assn. Jour.*, August, 1930, XXIII, 217.

Twenty case histories are presented, illustrating the various types of genito-urinary abnormalities. They are well illustrated by drawings and reproductions of radiographs.

The cases described embrace solitary cysts of the kidney (large as a football), unilateral absence of a kidney, simple displacement of a kidney on its correct side, floating kidney, renal vessel abnormalities, double ureter, persistent urachus, extroversion of the bladder, congenital obstruction of the urethra, either by epithelial occlusion of the meatus or by congenital valves in the posterior urethra.

L. J. CARTER, M.D.

**Intravenous Urography in the Diagnosis of Urological Diseases of Childhood.** Abraham Hyman. *Surg., Gynec. and Obst.*, September, 1930, LI, 409.

Since visualization with uroselectan depends upon the functional activity of the kidney, we have a roentgenologic functional test. The kidney shadow itself is intensified. Lack of visualization may mean non-functioning kidney, temporary inhibition, or absence of the organ. Normally, 95 per cent of the substance should be excreted within 8 hours, about three-fifths during the first 2 hours, one-quarter during the next hour, and the remain-

der in another 4 hours. In diseased or damaged kidneys, the rate of excretion is proportionately decreased, and the substance has been found in the urine as late as 6 or 8 days after the injection. The specific gravity of the urine in normal kidneys is greatly increased, often reaching as high as 1040 or 1045 within a few hours after injection.

The technic of administration is very simple. A child of 7 years of age receives one-half the adult dose (which is 40 grams), and a patient of 2 years one-quarter of the dose. The youngest injected in the author's series was an infant of 6 months.

In renal neoplasms in children, in which the entire kidney is often destroyed by tumor tissue, there is very little or no visualization, but where there is a definite palpable tumor on one side, cystoscopy may be dispensed with if the other kidney visualizes normally.

In 22 children injected, reliable diagnostic data were obtained in most cases by intravenous urography alone, and were of particular service in 4 cases in which, on account of severe cystitis, the ureters could not be visualized.

The author states that his experience would seem to indicate, when there is good visualization, the kidneys are probably functioning normally.

D. S. CHILDS, M.D.

**Diverticula of the Urinary Bladder in Women: Report of Cases.** Jay J. Crane. *California and Western Med.*, August, 1930, XXXIII, 572.

In the many cases of diverticula of the urinary bladder reported since the advent of the cystoscope and the improved X-ray technic, this condition in women is comparatively rare, comprising about 5 per cent of all the cases. The author reports four cases.

Under diagnosis he says: "Most diverticula are found during the process of a routine urological examination. This was true in our four cases in women. We were searching for the cause of their symptoms when the orifices of the diverticula were seen with the cystoscope. Cystoscopic examination will

usually reveal the presence of a diverticulum, but it alone cannot tell the whole story. An opaque catheter curled in a diverticulum, a cystogram, and a contrast cystogram taken in more than one plane will give an accurate idea of the size, exact location, number, and whether or not they are in a position to drain freely."

F. B. SHELDON, M.D.

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**Intravenous Urography.** Herman L. Kretschmer. *Surg., Gynec. and Obst.*, September, 1930, LI, 404.

The author states that uroselectan is non-toxic, non-irritating, without local reactions or local pain, except in one or two instances, but these were without systemic reactions such as chills and fever. Some of the patients complained of thirst and a sense of warmth which were transitory and disappeared rapidly. Congenital anomalies were easily demonstrated, bifid pelvis readily shown, and in one case a solitary kidney with a stone was shown, which was verified by operation. In one case of polycystic disease of the kidneys, the intravenous pyelograms were not as clear-cut as were the pyelograms made with ureteral catheters from below.

The best—that is the most easily readable—pyelograms and ureterograms were in cases of hydronephroses and hydro-ureters. In cases of unilateral involvement the affected side stood out in marked contrast to the normal side.

In the presence of renal and ureteral calculi, the intensity of the shadow was sometimes increased by the drug. The use of the drug demonstrated the presence or absence of complete obstruction with stone—an aid in determining an immediate operation. Failure to show the outlines of the ureters when there was fluid in the pelvis of the kidney and in the bladder was due to the absence of obstruction and normal, or possibly hyperactive, ureteral peristalsis. Because of the rapid elimination of the drug and its collection in the bladder, it is advisable to drain the bladder with a

catheter in those cases in which study is directed toward the lower end of the ureter. The rapid disappearance of dilatation of the ureter following the passage of stones and also following dilatation of strictures can be satisfactorily shown by means of the drug.

In renal tuberculosis satisfactory results are obtained where ureteral catheterization is impossible. In malignant tumors of the kidney, filling defects have been shown. If great destruction of kidney tissue has occurred, the intravenous pyelograms are not so clearly defined as in pyelograms made from below. This method may serve as a check on retrograde pyelograms.

Uroselectan has been used as a medium for making pyelograms from below, diluting the standard solution with equal parts of water, giving films that are beautifully clear-cut. The drug is non-irritating and there results practically no reaction from its use in this way.

D. S. CHILDS, M.D.

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**Concerning the Roentgenologic Demonstration of the Kidneys and Urinary Passages by Intravenous Injection of Uroselectan.** Karl Hutter and Max Sgalitzer. *Fortschr. a. d. Geb. d. Röntgenstr.*, June, 1930, XLI, 919.

This method was used on 110 patients between 14 and 76 years of age. The fact is repeated that besides anatomic information of importance, some knowledge regarding the functional ability of the renal parenchyma may be obtained. Illustrations show not only the value of the method in comparison and beyond that of retrograde pyelography, but also that at times the combination of both is necessary for a complete diagnosis. It is stated that in some cases of stasis one need employ only a fraction of the normal dose to obtain visualization. The necessity of individualizing roentgenographic procedure is stressed. This method was of importance in a case of renal tumor, which did not communicate with the pelvis and was not demonstrable by retrograde pyelography, but in

which intravenous pyelography revealed the area of destruction in the parenchyma.

HANS A. JARRE, M.D.

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**Intravenous Urography.** J. Sturdivant Read and Fedor L. Senger. *Long Island Med. Jour.*, September, 1930, XXIV, 469.

Uroselectan is easily prepared for use, 40 grams being given in 100 c.c. of water. The procedure is as simple as any other intravenous injection. The only subjective symptoms noticed are slight flushing of the face and some increase in the pulse rate, which soon disappear; in two hours most patients can resume their activities. Visualization of the kidneys, ureters, and bladder (by means of radiography) begins within five minutes of the completion of the injection, and usually three films, at half-hour intervals, will give sufficient information on which to base an opinion. The procedure by no means supplants cystoscopy and retrograde pyelography. Its special uses and indications are: (1) When for technical, anatomical, or pathological reasons cystoscopy and catheterization of the ureters cannot be performed; (2) when cystoscopy is contra-indicated due to risk of shock, etc.; (3) when the ureter is obstructed and the iodide cannot be injected beyond the obstruction.

W. W. WATKINS, M.D.

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**Intravenous Demonstration of the Morphologically and Functionally Normal Urinary Apparatus.** Josef Palugyay. *Wien. klin. Wchnschr.*, Aug. 7, 1930, XLIII, No. 32, p. 999.

The roentgen findings after intravenous administration of uroselectan are different from the findings in a retrograde pyelogram. The intravenous method was used with a normal urinary tract, in forty individuals. Peristaltic waves in the ureter and contraction of the kidney pelvis change the picture considerably from the one which is seen when a contrast medium is injected with pressure by means of a catheter. The kidney pelvis and the ureters

become the more distinct, the greater the filling of the bladder. For their demonstration it seems better to examine after the fluid intake has been restricted for some hours. Only changes in the configuration and not irregularities in the intensity of the parenchymal shadow should be considered pathological. Indistinct contours of the pelvis and calices are not abnormal; neither is the absence of some or all calices, as this may be caused by contraction. A ureteral shadow, continuous in its whole course or a great distance of it, points to a disturbed motility of the ureter.

Further observation of normal cases seems necessary, in the author's opinion, before optimal results may be achieved with this method.

H. W. HERKE, M.D.

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**Birth Traumatism as a Factor in Urinary Infection.** Frank S. Patch. *Canadian Med. Assn. Jour.*, September, 1930, XXIII, 381.

Two sequelæ of traumatism to maternal parts during parturition are cystocele and uterine prolapse. These so affect the bladder as to bring about in many cases an infection of the urinary tract. Cystocele is characterized by a sagging of the pelvic floor; thus there is formed a pouch, which, being lower than the fixed trigone, does not empty. This residual urine predisposes to infection, as does stasis anywhere.

In the diagnosis of urinary infection in the female, it is necessary to make a vaginal examination and look for any obstructive condition, such as cystocele. Residual urine should be detected and measured by the use of the catheter.

The method of cystography has recently been applied to the demonstration of bladder prolapse in the Urological and Gynecological Departments of the Montreal General Hospital. Cystograms are taken in the upright and the recumbent positions to show the comparison between the location of the bladder in the two positions.

Treatment of urinary infection, secondary to cystocele, consists in supporting the bladder in as nearly normal a position as pos-

sible, either by a pessary or by operation. If operation is done it should be only after acute inflammation has subsided. The essential feature of the operation is that permanent support should be given to the bladder floor, or that the bladder should be held in the normal position and in such a way as to give free and unimpeded urinary flow.

L. J. CARTER, M.D.

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**Intravenous Pyelography.** Albert Laroche. *Canadian Med. Assn. Jour.*, September, 1930, XXIII, 414.

The author briefly indicates the steps which led to the discovery of the possibility of visualizing the urinary tract by radiography, following the intravenous injection of some substance opaque to the X-ray. Following the intravenous injection of uroselectan, the author claims for "descending pyelography" all that can be accomplished by the cystoscope, the ureteral catheter, and the subsequent opaque injection, fulfilling the indications that ascending pyelography can meet. Furthermore, he claims for this new method that it enables one to determine the duration and power of evacuation of the kidney pelvis, the motor activity and permeability of the ureter, the diagnosis of diverticula, neoplasms, calculi, and the comparative functional capacity of the two kidneys. In addition, it can be used in many cases in which it is not possible to use the cystoscope and the ureteral catheter, such as contracted bladders and ureteral obstruction.

The author makes the rather startling claim that this recently introduced method should replace the cystoscope.

L. J. CARTER, M.D.

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**Intravenous Urography (Editorial).** William F. Braasch. *Surg., Gynec. and Obst.*, September, 1930, LI, 421.

After discussing the previous history of intravenous urography, the author makes the following comments: "A combination of iodine in high concentration with a pyridine ring had been discovered previously by Binz and Raeth of Berlin; this was called 'selectan-neu-

tral,' and was being employed intravenously as an antiseptic. Among the first to work with this solution was Hryntschak, who as early as 1927 employed it to outline the urinary tract in animals, but was unable clearly to demonstrate its feasibility for general use. Swick, a fellow on the Libman Foundation, working with Lichtwitz at Altona, recognized early in 1929 the value of the selectan group in outlining the urinary tract following intravenous injection. However, it proved to be toxic in some cases and the shadow of the renal pelvis was frequently uncertain. Working with von Lichtenberg and Swick, Binz made various modifications which obviated the objectionable features, leaving a substance which on intravenous injection was not toxic and which outlined the pelvis and ureter sufficiently to permit interpretation of an existing abnormality. This substance was called 'uroselectan.' With characteristic Teutonic thoroughness von Lichtenberg insisted on an exhaustive trial by a group of representative American urologists before uroselectan should be distributed for general use; their results were submitted at a recent meeting of the American Urological Association.

"Uroselectan is now available for use by the medical profession and undoubtedly will prove to be a valuable adjunct to general diagnosis. Judging from the experience of those who have employed it, its greatest value probably will be in determining the condition of the kidneys in cases in which ureteral catheterization is difficult or impossible. This would include intolerant patients; patients with contracted tuberculous bladder, anatomical obstruction of the ureter, extensive vesical neoplasm, prostatic obstruction, impassable stricture of the urethra; patients who have undergone rectal implantation of the ureters; infants and patients in whom introduction of the cystoscope is difficult because of deformities. The intravenous method permits bilateral pyelography without any of the dangers accompanying bilateral retrograde pyelography; this should be of particular value in the presence of polycystic kidney, bilateral hydronephrosis, and fused and solitary kidney. It will also be a valuable adjunct to the list

of tests of differential renal function, which frequently have left doubt as to the functional capacity of the kidney under investigation. Incidentally, uroselectan offers a much better medium for retrograde pyelograms than sodium iodide in that it has none of the irritating qualities of the latter, and, because of the large content of iodine, it casts a dense shadow.

"Although the method of intravenous urography is now available to the general profession, it must be remembered that the interpretation of the urogram is frequently difficult and should be referred to those who have had extensive experience.

"It should be emphasized, moreover, that although in some cases the use of uroselectan may render cystoscopic examination unnecessary, nevertheless its interpretation will often have to be accompanied by cystoscopic data in order to complete the diagnosis.

"It will be found that the outline of the pelvis and calices is not always distinct in the urogram obtained by intravenous injection and that minor evidence of abnormality, such as occurs with renal tumor and renal tuberculosis, is easily overlooked. In doubtful cases a retrograde urogram will be necessary.

"Thus, by the work of various contributors, intravenous urography has now been placed on a practical basis. That it will prove to be a valuable adjunct to urologic as well as to general abdominal diagnosis and surgery is evident."

D. S. CHILDS, M.D.

## GYNECOLOGY AND OBSTETRICS

**Histological Study on the Effects of X-rays on the Ovary during the Period of Oögenesis.** Georges Gricouroff. *Radio-physiologie et Radiotherapie*, 1930, Vol. II, Fasc. I, 1.

This is a lengthy and detailed account of an experimental study upon this subject. The author points out that in previous work on the effects of X-rays on the ovary recorded in the literature, adult animals, usually rabbits, were used. It is well known that in these ani-

mals the function of oögenesis ceases before puberty, and most previous work, therefore, relates to the effects of the rays upon the mature ovary. The author used in his experiments young pre-pubescent rabbits. The irradiation technic was the same in all the experiments, the conditions being as follows: Secondary voltage 150,000, filter 4 mm. aluminium, anticathode-skin distance 26 cm., duration of exposure from 20 to 28 minutes. The dosage under these conditions worked out at from 4,500 to 5,000 Solomon r-units, and a single abdomino-pelvic field was employed. It was found that the ovary, when in an active condition of oögenesis, could be totally destroyed by a single application of X-rays, using the above technic. The earliest effect, observed one hour after the irradiation, was the cessation of karyokinetic activity in both the connective tissue and epithelial cells. The individual elements in the developmental chain of the sexual cell showed different degrees of sensitivity, the oögonia being the most sensitive and the mature oöcytes the least. The *follicular cells, although not distinguishable* histologically from the oögonia, were found to be relatively insensitive. There is, accordingly, a radiophysiological parallelism between the homologous stages in the development of the male and female sexual cells, the germinal cells in both cases (spermatogonia and oögonia) showing a high degree of sensitivity. The vascular endothelium, both of the capillaries and the larger vessels, appeared to be unaltered. Marked, though very temporary, changes were also observed in the epithelium of the fallopian tubes.

WALTER M. LEVITT, M.B., D.M.R.E.

**Temporary Amenorrhea in the Treatment of Endometrial Tumors of Ovarium and Peritoneum.** Hans Albrecht. *Strahlentherapie*, 1930, XXXVII, 584.

The history of four women is related who were suffering from extensive endometrial ovarian hematomas, combined with more-or-less advanced involvement of the rectovaginal septum. They were treated by temporary

roentgen amenorrhea, with excellent results. It is suggested, therefore, that this treatment be given preference in suitable cases.

ERNST A. POHLE, M.D., PH.D.

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The Clinic of Temporary Roentgen Amenorrhea. C. J. Gauss. *Strahlentherapie*, 1930, XXXVII, 511.

This excellent article presents the problem of temporary roentgen amenorrhea in a complete, concise manner. Following a brief discussion of the nomenclature and the history, the dosage methods are summarized. The single treatment method seems to be preferable, and the dose should be measured in the vagina during the treatment. The author then analyzes the relations between the time of the treatment and the beginning of the amenorrhea, as well as those between dose and duration. Among the clinical symptoms there were vasomotor and nervous disturbances but very little change in the sexual life and no trophic changes (increase in weight, atrophy of vulva, vagina, and uterus) as observed in permanent amenorrhea. The menstruation is usually normal after its return. The author does not consider the presence of diabetes, severe heart lesions, tuberculosis, and similar disease in young women, as justifiable indications for temporary roentgen amenorrhea, because the prevention of conception can not be guaranteed. If the menstruation as such aggravates an existing disease, temporary amenorrhea has often brought about relief. In cases of menorrhagia, it should be carried out only as a last resort; the same holds true of severe dysmenorrhea. In uterine fibroids in young women, it may be used to advantage.

Very interesting also are the good results reported by several authors in cases of endometrioma. Pelvic inflammatory diseases, both of gonorrheal and tuberculous etiology, are greatly improved by temporary sterilization.

As to the contra-indications, it is stated that not all authors agree with Wintz, who does not accept any contra-indications. It certainly should not be carried out merely for the purpose of preventing conception over a limited period of time. The dangers connected with the treatment are the same as for any other roentgen exposure. In view of the relatively small dose required, no severe skin reactions should occur. A more serious possibility is the chance of producing permanent amenorrhea. Only careful measuring of the dose applied can reduce this chance. According to Wintz, only 4 per cent of all women under 35 years responded with permanent amenorrhea, following treatment for a temporary sterilization. The question of a possible tendency to abortion can not be definitely decided. The injuries to the offspring really do not belong to the dangers of temporary sterilization, since only the accidental irradiation of an embryo within the uterus may lead to abnormalities. Numerous tables compiling the cases of children born to irradiated mothers and their further histories are then summarized by the author.

In conclusion, it is stated that the danger of injury to the offspring exists during the entire pregnancy, if the uterus is irradiated directly. The injury to the germ plasma depends on the time of irradiation. If treatment for temporary amenorrhea is carried out and impregnation of the ovum takes place before the beginning of the amenorrhea, the developing pregnancy should be interrupted. A so-called "late injury" has not been proved so far. This refers to women who became pregnant after the resumption of the menstruation. The author uses temporary sterilization by roentgen rays in his clinic only in women who in all probability would not become pregnant any more, and in women to whom no other treatment procures relief.

ERNST A. POHLE, M.D., PH.D.

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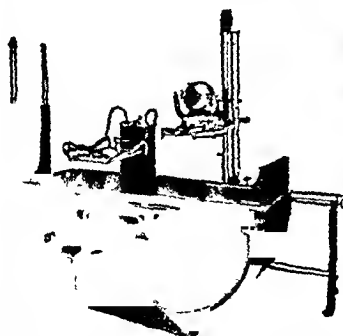
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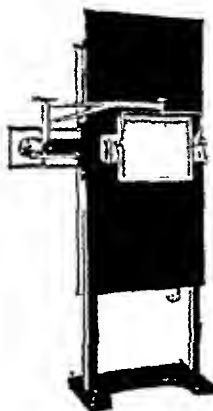
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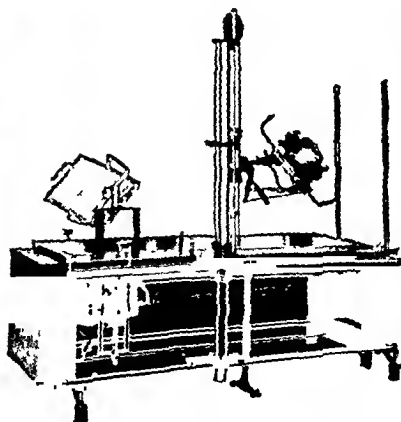
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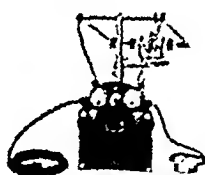
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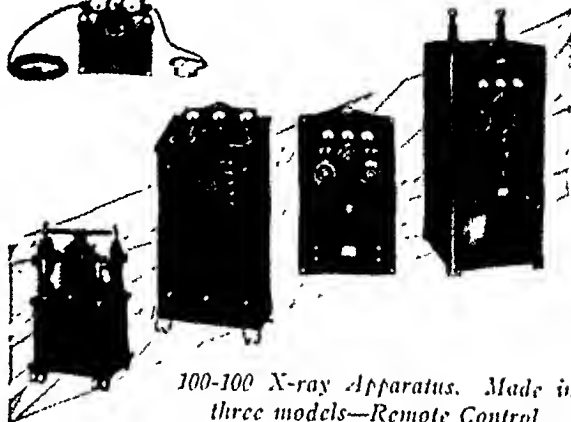
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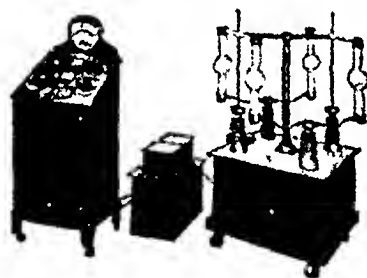
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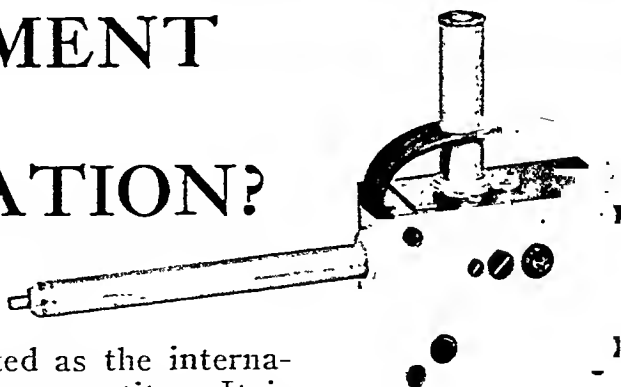
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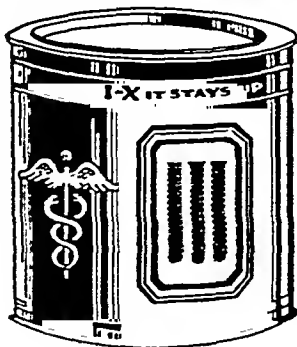
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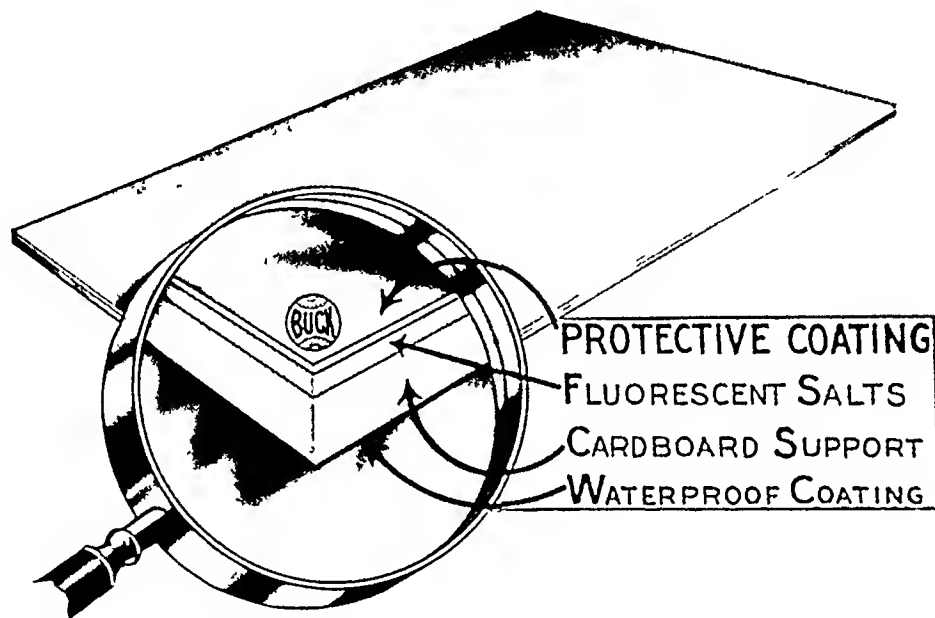
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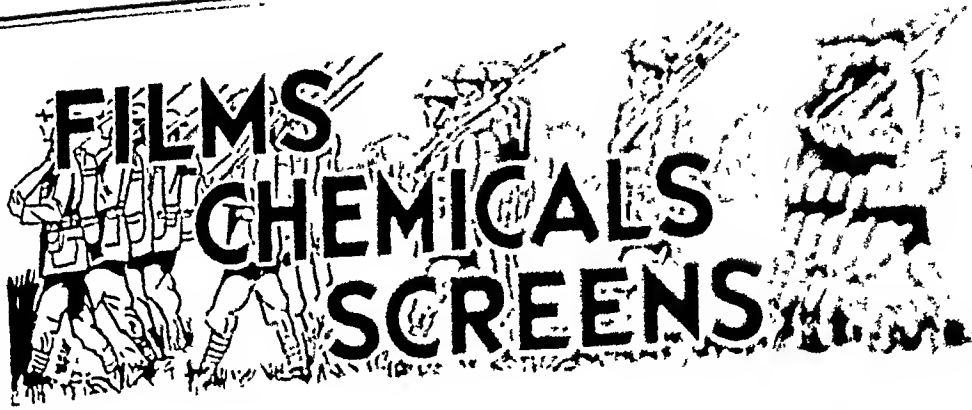
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